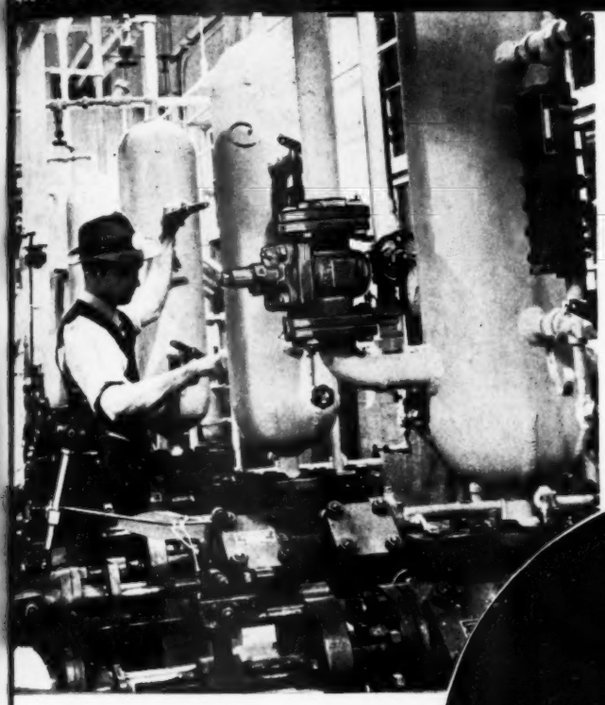
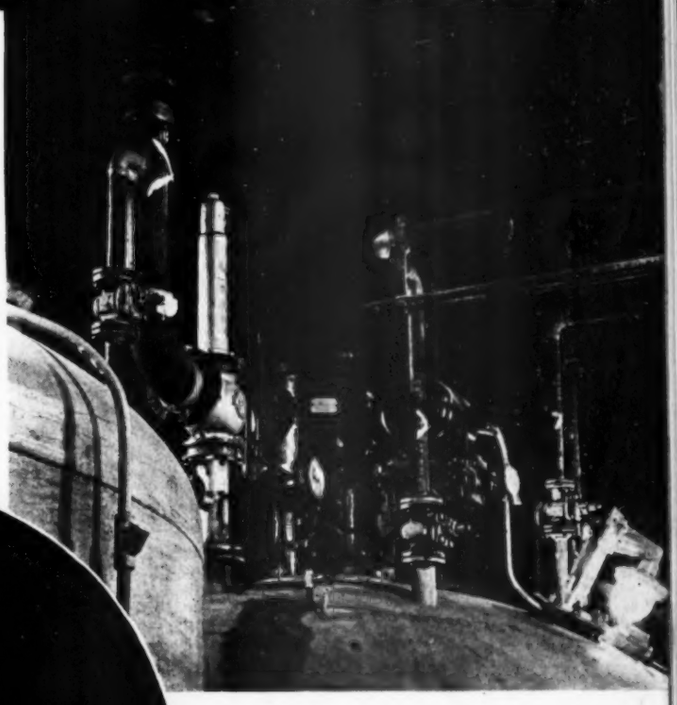
DRILLING AND PRODUCTION

PIPE LINE

REFINING NATURAL GASOLINE



Another RUBBER TREE - American Grown



UMP HOUSE—Raw materials, butadiene, yrene and special chemicals are pumped from storage to reactor areas.

REACTORS—A total of 72 reactors are used for annual production of 90,000 long tons of synthetic rubber.

SYNTHETIC RUBBER PRODUCTION REQUIRES NORDSTROMS

keep upkeep down

Photos, by courtesy of United States Rubber Co.

LENDING TANKS—Synthetic rubber is atched and blended in twelve 30,000-gal- n concrete storage tanks. Then pumped to other tanks for coagulation.

PURIFICATION—Before butadiene is pumped to reactor area, the inhibitor, previously added to prevent premature polymerization, is removed in this apparatus.

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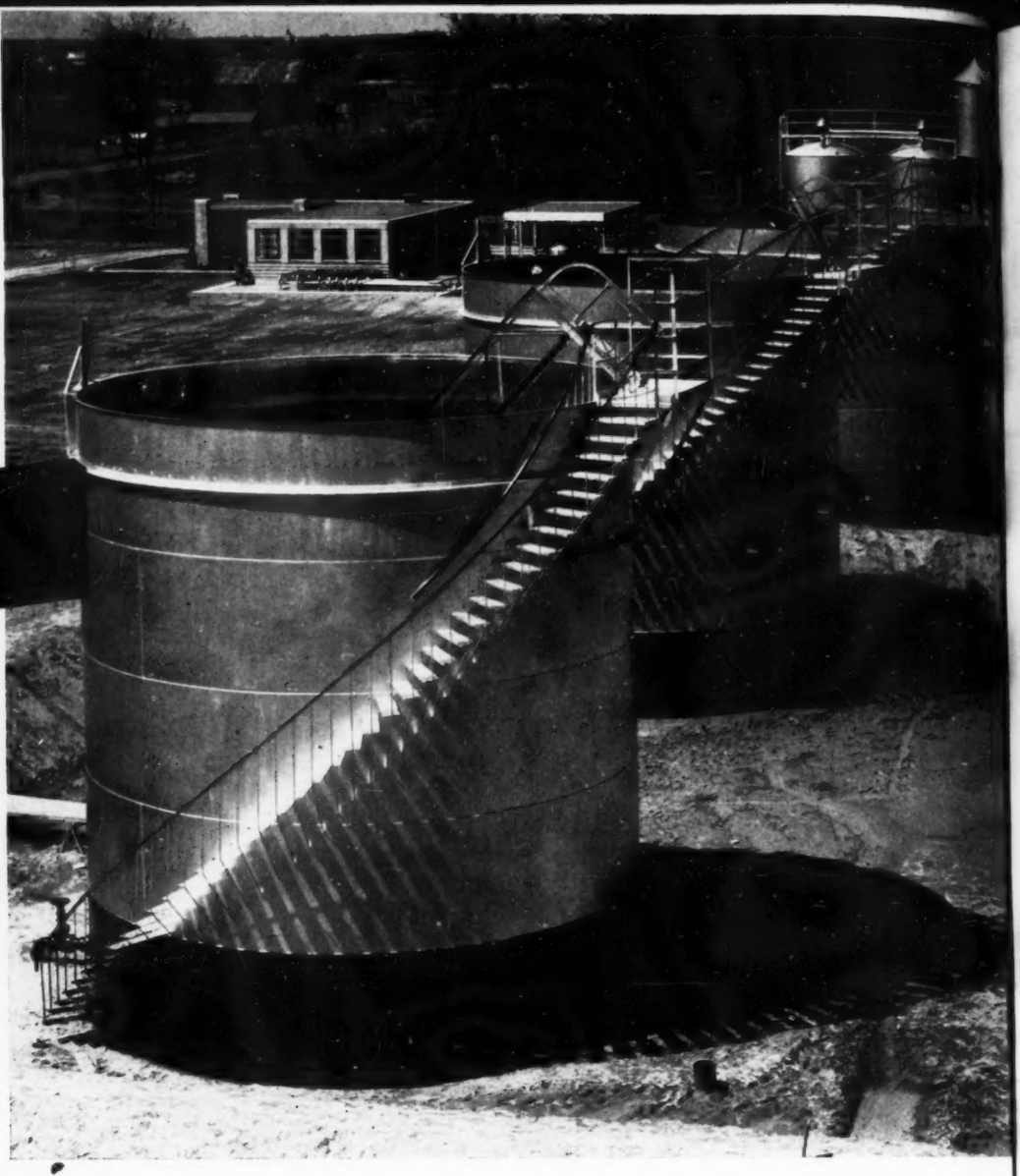

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August, 1943

THE Petroleum Engineer

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MEMBER A.B.C.—A.B.P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N. Y.)

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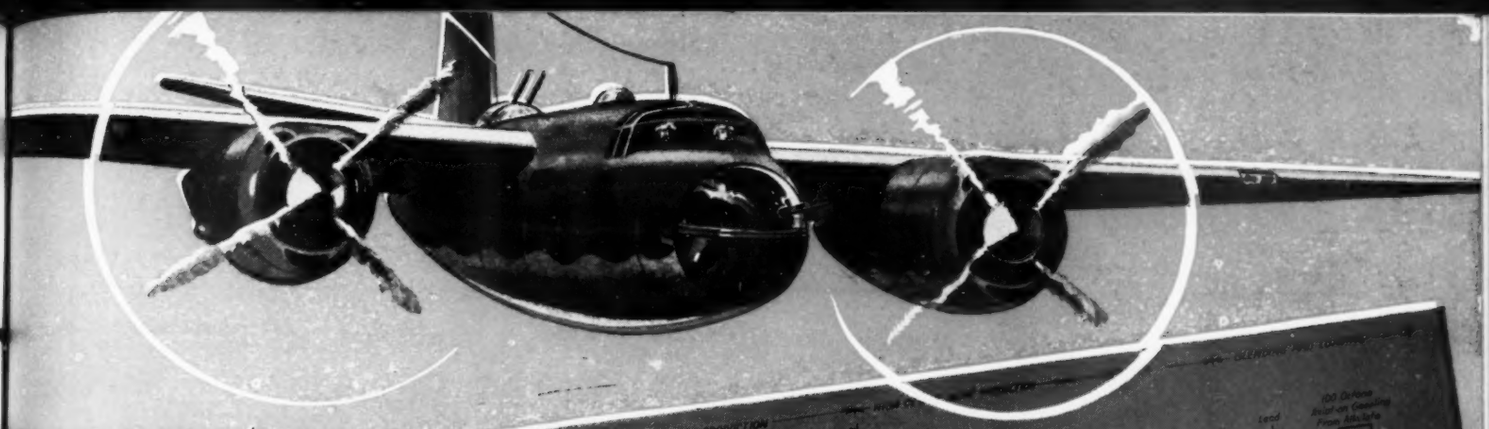

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High Octane Aviation Gasoline, a product of American refining genius and stick-to-it-iveness, has come a long way since the Army Air Corps placed its first experimental order in 1935.

But this "Super Fuel" is only the beginning of combining several processes for the production of specialized products. Other combinations are on the drafting tables now—others, still unborn, are in the test tubes of closely guarded laboratories.

However, to adapt intelligently these processes requires the knowledge and ability to co-ordinate oil field recovery methods with available or possible additional refinery facilities.

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The Course of Oil

by K. C. SCLATER

DOMESTIC CRUDE SUPPLY

Solution of the problem of war-time transportation of oil to the Eastern seaboard is a magnificent achievement. Likewise, a magnificent job is being done by refiners in converting their plants for the manufacture of war products; but now that these transportation and refining facilities are available, the country is faced with an actual shortage of crude oil. This is being brought home to the public in the Middle West and Southwest by further gasoline rationing restrictions.

This shortage of oil is no fault of the industry. It is the result of conflicting views among Washington officials. For more than two years an adequate drilling program has been advocated by the oil industry, a program that would be likely to result in the discovery of new oil reserves in sufficient quantity for probable eventual war needs. Instead of adopting such a program, governmental authorities curtailed drilling activities. Had a reasonable quantity of steel been allocated for drilling and producing needs, and a general increase in the price of crude oil been granted, there is little doubt that the shortage we now face might have been forestalled.

Despite the apprehension that has prevailed, even in government circles, because of the serious drainage of our national oil resources by the mounting demands of war, the industry has been deterred from doing anything about it. True, restrictions on steel have recently been relaxed to some extent but the matter of price appears still to be as far from settlement as it was a year ago.

Unfortunately, the question of granting a general increase in the price of crude oil has developed into a national issue and become involved in a maze of political maneuvering. It is a sad commentary on bureaucratic bungling that has no place in the war effort. It stems from the failure by certain authorities in Washington to take a realistic view of the possibility of an oil shortage and its probable consequences.

For several years the rate of crude production has exceeded the quantity of new oil discovered. With the exception of two areas, all fields are now producing at capacity. Any further increase in the rate of production from existing oil fields threatens to do irreparable harm by reducing still further our present oil reserves. Oil men as a whole frankly are worried. They are doubtful that enough crude oil can be discovered in the United States in time to satisfy the demands of the military, war industries, agriculture, and essential civilian needs, but they stand ready to prevent a threatened shortage of crude if given the necessary incentives.

PAW officials have all along been acutely aware of the necessity for discovering new oil reserves. They recently announced that the wildcat drilling program for 1943 should be increased from 4600 to 5200 wells, and have made a request of the WPB for an extra allotment of steel for that purpose. It is evident that the discovery of new oil reserves in 1943 will be inadequate to meet eventual war demands.

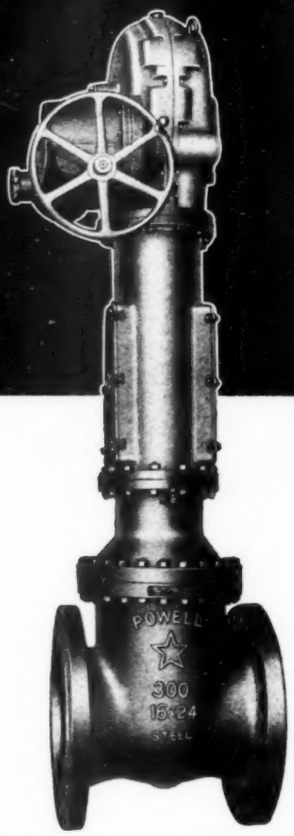
According to PAW, between December, 1941, and July, 1943, stocks of crude oil above ground in the Middle West have declined from 29,000,000 barrels to 19,000,000 barrels. These figures are net after deducting 50,000,000 barrels, the volume of crude oil tied up in a working inventory. This minimum working stock of 50,000,000 barrels is an estimate on which both the PAW and the petroleum industry are agreed. These above-ground crude oil stocks refer particularly to the Middle West, where the total daily crude production has dropped from an average of 1,180,000 barrels in December of 1941 to 950,000 barrels during July of this year. Judging by the total decline in fields now producing, little hope is held for reversing this declining trend.

The necessity for refining and producing war products has compelled refiners to change their yield. Before December, 1941, 37 percent of the yield of each barrel of crude was converted to gasoline for civilian consumption. In 1942, this yield was reduced to about 31 percent. Today only 25 percent of each barrel of crude that comes from the refinery is gasoline for civilian consumption.

These and many other data regarding crude costs and their relation to wildcatting activities have been submitted to Washington authorities in support of the need for a general increase in crude prices. The evidence is overwhelming that the logical, quickest, and most economical way to increase the oil reserves of the nation at this critical time is by granting a reasonable general increase in the price of crude and allocating sufficient steel to carry on an intensive drilling program. Unless this is done, the drilling and producing branch of the industry must flounder along in a welter of indecision and doubt. This is a wholly inconsistent position when the need for action is so imperative. A high military official has asserted that 65 percent of the supplies shipped to our armed forces overseas is petroleum products. Is that not the strongest factual evidence of the importance of petroleum in war and a sufficiently compelling reason for the government to take immediate, appropriate action that will enable the industry to engage in an intensive oil-finding campaign?

Meanwhile, the day of an actual crude shortage draws nearer. Confronted with this fact, Washington authorities have suggested the importation of crude oil from Venezuela and other South American fields to make up any deficiency in domestic supplies. Whether such a move has been behind all the political maneuvering is not known, but if it has, the industry has been hoodwinked.

That a shortage of domestic crude oil should be allowed to occur at this time is incomprehensible. We are at war, and the safety of the nation far transcends any question, much of it based on specious theory, on what effect a general increase in the price of crude oil will have on the national economy.



Another striking example of Powell engineering —this valve is one of several specially designed and built by Powell to be used in a large Southwestern refinery for making synthetic rubber. It is a Class 300 pound, 16-inch port size Cast Alloy Steel Gate Valve with flanged ends venturied to 24-inch pipe size to accommodate insulation on inside of pipe. It is operated by an electric, top-mounted, fully enclosed, explosion-proof motor operator for quick, positive opening and closing.

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Highlights IN OILDOM

Oil Companies Lose in Mexican Suits

The Mexican Supreme Court has ruled against foreign oil companies in another of a series of suits growing out of the 1938 expropriation. The court ruled that the companies, upon being expropriated, automatically lost their rights to fight Mexico's petroleum laws.

The companies suing, led by the Juasteca Petroleum Company, a subsidiary of the Standard Oil Company of New Jersey, had attacked the legality of laws giving the government subsoil rights.

Salt Water Injection in East Texas

During the month of June, 5,727,418 bbl. of salt water were returned to the Woodbine sand in the East Texas field through 56 active injection wells, according to figures in the Kilgore office of the Texas Railroad Commission. Injection averaged 190,914 bbl. a day for the month, the highest figure on record.

A total of 2647 wells in the field are now connected to salt water injection facilities. The volume of salt water injected since the beginning of the program has attained a total of 93,319,097 bbl.

Eighteen of the injection wells are operated by the East Texas Salt Water Disposal Company, which injected a total of 3,149,598 bbl. during June. Other injection well operators are General American Oil Company, two wells; Gulf Oil Corporation, three; Humble Oil and Refining Company, three; Magnolia Petroleum Company, four; Ohio Oil Company, four; Richardson Oils, Inc., one; Selby Oil and Gas Company, two; Sinclair Prairie Oil Company, eight; Stanolind Oil and Gas Company, two; The Texas Company, seven, and G. H. Vaughn, two.

Move to Expedite Handling of Oil Problems

Establishment of the District 3 office of the Petroleum Adminstration for War on a decentralized basis under the direction of D. E. Buchanan, is announced by Deputy Administrator Ralph K. Davies.

At the same time, Davies signed a delegation of administrative authority over certain aspects of oil production operations in the Southwest to Buchanan as director-in-charge.

Effect of the two actions, the Deputy Administrator said, should be to materially expedite the handling of wartime petroleum problems in the Southwest area—the most important in the nation from a production and refining standpoint—because of the on-the-ground treatment those problems will receive from PAW officials conversant with local conditions and needs.

Under the decentralization plan, the District 3 office at Houston, Texas, will serve henceforward as PAW's primary point of contact with the petroleum industry in that district, which embraces the states of Texas, Alabama, Mississippi, Louisiana, Arkansas, and New Mexico.

In announcing the placing of the district on a decentralized footing, Davies stated that members of the petroleum industry in District 3 hereafter will deal with Buchanan and his associates "in regard to all ordinary matters of mutual concern" as the principal contact with the Petroleum Administration. The various industry committees in this district likewise were requested to deal directly with the district office, instead of with Washington.

"We believe," Davies said, "that this arrangement will work to the advantage of both the industry and our own organization, assuring prompter action, better answers through a closer knowledge of local needs and conditions, and making it unnecessary for representatives of the industry to come all the way to Washington to get adequate consideration of their problems."

The delegation of administrative authority to Buchanan over certain phases of production operations transfers to the field much of the administration of Petroleum Administrative Order No. 11, which outlines standard conditions governing the use of materials for oil field exploration and development.

The effect of the delegation is to give Buchanan authority to deny and grant exceptions to PAO No. 11 in a wide variety of cases, all of which are set forth in the delegation. The result will be to eliminate the necessity for reference of applications for exceptions to Washington and thus expedite their processing.

Liquid Fuel From Shale Considered

Three senators are investigating the practicality of supplementing the nation's petroleum reserves through the manufacture of liquid fuels from coal and oil shale. They compose a committee that is considering S-1243, a bill for that purpose already introduced in Congress.

The congressional group interviewed representatives of the military service, labor and industry in Washington, then went to Pittsburgh, Pennsylvania, to study the coal-gas engine that is part of an experimental plant built with a recent $100,000 congressional allotment to determine the worth of construction of such refineries.

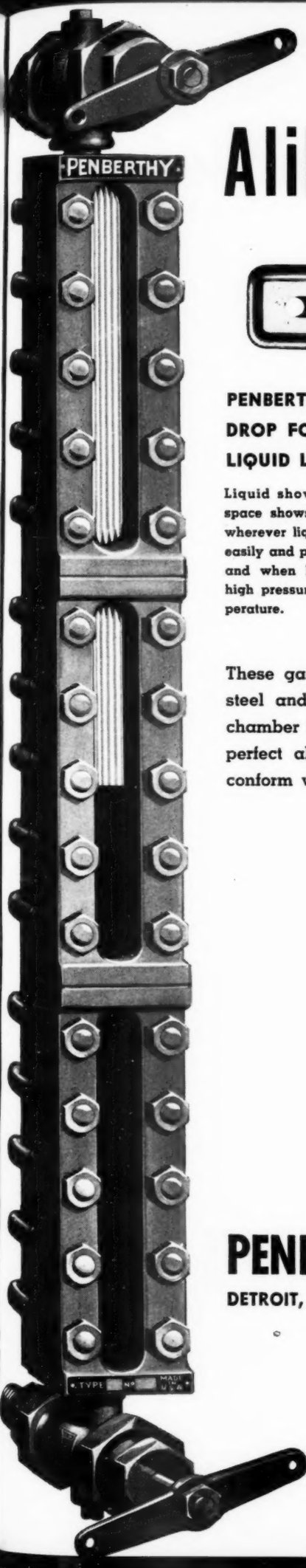
The investigation of the hydrogenation plant for this particular purpose was continued in Salt Lake City, Utah, and Sheridan, Wyoming, both of which are in areas where large supplies of the shale exist.

California Discovery Wells Given Bonus

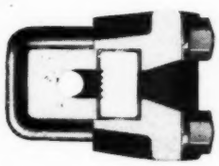
An inducement to California oil operators to engage in exploratory drilling has been announced. The Production Committee for District No. 5 is offering a bonus allowable to any well successfully completed and discovering a new oil pool. The announcement was made by E. E. Pyles, chairman of the Production Committee, in a letter to all California oil producers. Pyles says: "The most practical and logical reward which can be offered within the scope and authority of the Production Committee is to grant a bonus crude oil allotment to any well which constitutes a 'new discovery.' I believe the reward granted by the Production Committee to those operators who are successful in their wildcat drilling is generous."

Allocation to discovery wells increases progressively with increasing depth, Pyles stated. The committee has prescribed both the total barrels to be allocated, as well as the daily rate of production. Wells drilled to a depth of 2000 ft. are given a total allocation of 30,000 bbl., to be produced at a daily rate of 325 bbl.; whereas wells of 10,000-ft. depth receive 150,000 bbl., to be produced at a daily rate of 525 bbl. The scale is graduated for intermediate and other depths. In no case, however, is any well granted an allotment greater than its capacity to produce.

The ruling applies to any new discoveries completed subsequent to May 1, 1943. Limiting conditions under which discovery wells may participate in the bonus are set forth. Certification of any such wells to determine that they have made a discovery is necessary. Production at the bonus rate is not extended to wells with extremely high gas-oil ratios nor where the natural gas produced with the crude oil cannot be utilized. Also, production may not be greater than the volume that can be transported and marketed. Completion of an offset well located in the same pool within 1320 ft. of the discovery well will terminate the bonus allotment to the discovery well.



Alike in Quality



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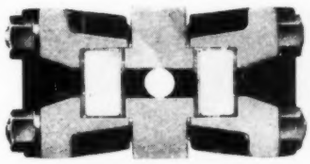

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PENBERTHY PRODUCTS

MAJOR *Refining* ACTIVITIES

THE Gulf Oil Corporation recently began the manufacture of nitration grade toluene at its refinery in Philadelphia, Pennsylvania, in a modern unit built at the request of the Army Ordnance Department and constructed entirely by funds of the company. The raw material for the new toluene producing plant is gasoline obtained from existing facilities and the final product will be delivered to TNT producing plants and eventually will be an integral part of the explosive bombs and shells to fall on Berlin and Tokyo.

Built under high priority ratings, the new Gulf unit is the second to be constructed along the eastern seaboard. Most other petroleum toluene plants are situated in the west and south.

Speaking of the new plant, a spokesman of the Gulf companies paid high tribute to the various governmental agencies that coöperated in its erection. In World War I, nearly all toluene of the quality needed for the manufacture of explosives was produced by the coal tar industry; however, during the final stages of the past war a small amount was manufactured from crude oil fractions.

Today, a greater portion of toluene being processed at the ordnance explosive centers is coming from the nation's oil refineries. In the production of this material at the Gulf plant, the charge used is a straight-run gasoline extracted from crude oil. This is run into a series of fractionating columns where the toluene is extracted. The new Gulf plant was erected by the Foster Wheeler Corporation and the output is a strict military secret.

The refinery, a 6-in., 299-mile pipe line, and an oil compounding plant of the Globe Oil and Refining Company, McPherson, Kansas, have been purchased by the National Coöperative Refinery Association, said to be the largest cash transaction in the history of coöperatives. The refinery, constructed in 1932, has a maximum capacity of 17,500 bbl. of crude oil daily. The refined products pipe line is laid from McPherson to Council Bluffs, Iowa.

Frank E. Holsten, Chalmette Petroleum Company, New Orleans, was reëlected president of the Gulf Coast Refiners Association, and all other officers were reelected to their respective posts at the annual meeting in Houston, Texas. Other officers are: George O. Irvine, American Republics Corporation, Houston, and John A. Bartlett, American Mineral Spirits Company, Corpus Christi, vice-presidents; L. F. Rothermel, Maritime Oil Company, Houston, treasurer, and George Reid, executive secretary.

Holsten will continue to represent the association on the Petroleum Industry War Council and serve as a member of the Petroleum Administration for War, District 3, as in the past.

The styrene plant of Dow Chemical Company in the Los Angeles area has been completed in part and placed in operation. Production began six weeks ahead of schedule, Dow officials stated. The styrene output is one unit in the coördinated synthetic rubber production in that area. Other plants are the butadiene refinery of Shell Oil Company and the rubber polymerization plant of Goodyear Tire and Rubber Company.

This is the fourth plant of this kind built by Dow. The company began production of styrene in its main plant at Midland, Michigan, in 1936. Another unit of the Los Angeles refinery is scheduled to begin production this month, which will more than double present output.

An interesting point about the styrene plants is that every use consistent with efficiency has been made of regulating instruments that enable the plant to operate almost automatically, at the same time maintaining close control over the quality of the finished product.

The Sullivan City, Texas, oil field will have a new oil pipe line gathering system, it was announced by H. L. McBride, owner and operator of a refinery at La Blanca. An area of about 10 miles will be serviced by the pipe line and all 30 wells in the field will have the opportunity to connect with it.

Trucks will transport the oil from Sullivan City to the refinery at La Blanca. Eighty percent of the refinery output goes to the government.

Dr. R. H. Waser, manager of the Shell Oil Company refinery at Deer Park, south of Houston, Texas, has been transferred to the position of manager of operations in the manufacturing department, New York. P. E. Foster, manager of the Shell refinery at Norco, Louisiana, will succeed Doctor Waser as manager of the Texas plant.

Cities Service Company's large new Lake Charles, Louisiana, refinery will absorb the subsidiary Arkansas Fuel Oil Company's Bossier City refinery, one of the largest in that area. The Bossier City plant will close permanently when production begins at Lake Charles, according to company officials.

Crude Runs to Stills, Production[1] and Stocks[2] of Motor Fuels
Week Ended July 31, 1943
A.P.I. Figures
(Figures in thousands of bbl. 42 gal. each)

DISTRICT	DAILY REFINING CAPACITY		CRUDE RUNS TO STILLS[3]			
*Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas	Potential Rate	Percent Reporting	Daily Average	Percent Operated	Total Production	Total Stocks
	2,444	88.7	1,789	73.2	11,669	65,952
Appalachian	177	84.8	139	78.5	766	4,100
Ind., Ill., Ky.	824	85.2	702	85.2	4,422	25,555
Okla., Kans., Mo.	416	80.1	320	76.9	2,016	10,429
Rocky Mountain	147	55.9	93	63.3	561	2,706
California	817	89.9	745	91.2	5,123	78,788
TOTAL U. S.—JULY 31, 1943	4,825	86.4	3,788	78.5	24,557	187,513
TOTAL U. S.—JULY 24, 1943	4,825	86.4	3,973	82.3	25,094	187,582
U. S.—AUG. 1, 1942			3,685		22,551	206,192

*At the request of the Petroleum Administration for War.

[1]Production—total of gasoline at refineries including natural and blended; kerosine, gas oil and distillate fuel oil, and residual fuel oil.

[2]Stocks—at refineries, bulk terminals, in transit, and pipe lines of finished and unfinished gasoline; kerosine, gas oil and distillate fuel, and residual fuel oil.

[3]Figures on production and stock include reported totals plus an estimate of unreported amounts; therefore are on Bureau of Mines basis.

Refineries at Baytown and Texas City, Texas, were greatly damaged by the storm on the Gulf Coast last month. The Baytown refinery was hit harder than by any storm since it was built in 1919. The incomplete butyl rubber plant lost a cooling tower. Cooling towers were evidently most susceptible to the force of the hurricane. The General Tire and Rubber Company's Buna S synthetic rubber plant suffered damage as well as the Humble plants. The Republic Oil Refining Company reported three cooling towers down and other damage, and the Southport Petroleum Refinery sustained heavy water damage because it is built on low ground and much of it was under water for some time.

A LESSON IN WATER COOLING

LESSON 6 OF A SERIES

WATER SUPPLY PIPING

The supply piping of a water cooling tower is comprised of *inlet* and *distribution* piping.

The inlet piping includes the external supply line and vertical risers that convey the water to the top of the tower and deliver it to the distribution system. The inlet piping is not considered a part of the cooling tower proper and therefore is not customarily furnished with the tower equipment.

The distribution piping is an integral part of the tower and is composed of headers, laterals and the outlets for spreading the water evenly over the tower area above the internal filling. The design and construction of this piping will vary with the manufacture, type and size of tower as well as with the service requirements.

When selecting a cooling tower for a given job the following factors relative to the supply piping should be considered.

1. The number of vertical supply risers and the installation of valves should be such as to provide necessary flexibility and control for proper operation of the cooling tower under all conditions.

PROPERTIES OF STANDARD CLASS "A" C. I. PIPE*

Pipe Size	Outside Diam.	Wall Thickness	Weight per Foot	Int. Area
4	4.84"	.42"	18. lb.	12.56 sq. in.
6	6.88"	.44"	27.9 lb.	28.27 sq. in.
8	8.92"	.46"	38.7 lb.	50.26 sq. in.
10	11.0"	.50"	51.9 lb.	78.54 sq. in.
12	13.08"	.54"	67. lb.	113.10 sq. in.
14	15.14"	.57"	82.3 lb.	153.94 sq. in.
16	17.20"	.60"	98.8 lb.	201.06 sq. in.
18	19.28"	.64"	118.3 lb.	254.47 sq. in.
20	21.34"	.67"	137.4 lb.	314.16 sq. in.
24	25.52"	.76"	136.5 lb.	452.39 sq. in.
30	31.76"	.88"	266.1 lb.	706.86 sq. in.

*From Handbook of Cast Iron Pipe, C. I. Pipe Research Assn.

2. External vertical risers as well as inlets to the distribution piping should be of such size as to provide normal friction losses.
3. A careful study should be made of the size and length of external supply line alongside of the tower. The shorter this supply line and the fewer the risers, the lower the comparable cost will be.
4. The distribution piping system should be of such design as to permit considerable variation in water quantity circulated without measurably decreasing its effectiveness.
5. The distribution system should be accessible for inspection and cleaning.

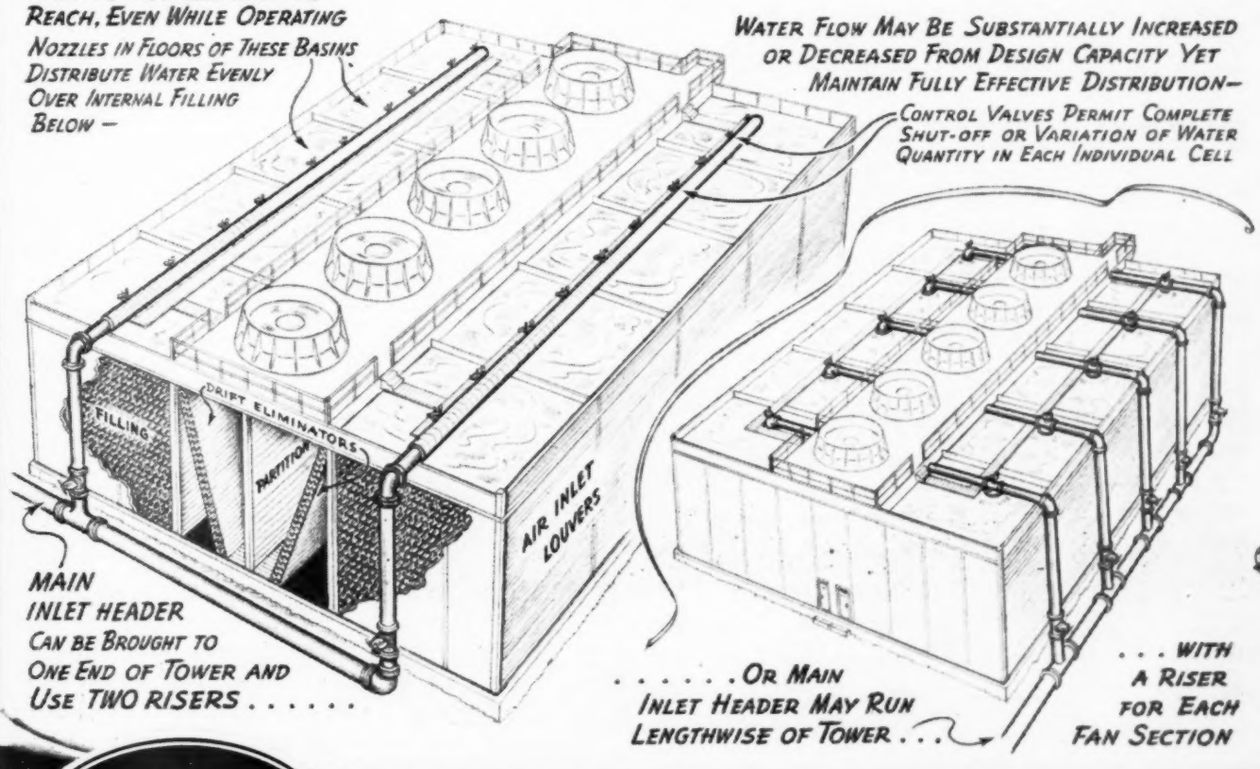
AN EXAMPLE OF GOOD PIPING— THE MARLEY DOUBLE-FLOW COOLING TOWER

ENTIRE DISTRIBUTION SYSTEM OPEN TO VIEW AND EASY TO REACH, EVEN WHILE OPERATING

NOZZLES IN FLOORS OF THESE BASINS DISTRIBUTE WATER EVENLY OVER INTERNAL FILLING BELOW —

WATER FLOW MAY BE SUBSTANTIALLY INCREASED OR DECREASED FROM DESIGN CAPACITY YET MAINTAIN FULLY EFFECTIVE DISTRIBUTION—

CONTROL VALVES PERMIT COMPLETE SHUT-OFF OR VARIATION OF WATER QUANTITY IN EACH INDIVIDUAL CELL



MAIN INLET HEADER CAN BE BROUGHT TO ONE END OF TOWER AND USE TWO RISERS . . . . . .

. . . . . OR MAIN INLET HEADER MAY RUN LENGTHWISE OF TOWER . . .

. . . WITH A RISER FOR EACH FAN SECTION

MARLEY COOLING TOWERS

THE MARLEY COMPANY INC.
KANSAS CITY, KANSAS

83-A

MAJOR *Oil Field* ACTIVITIES

▶ **Oklahoma.** Stanolind Oil and Gas Company No. 1 Cashian Community, NW NE SE 31-4-1, opened a new pool in Garvin County with a potential of 2000 bbl. of oil a day. Production is through perforations between 4040-129 ft.

▶ **Mississippi.** The third pool discovered in the state this year is believed to be opened by Gulf Refining Company No. 1 Alden Davis in Wayne County. Located just across the Jones County line, the well was reported to have had one showing of oil at about 5000 ft. and another good showing at 6700 ft. in the lower Tuscaloosa formation massive sands.

▶ **Texas.** Indications point to the discovery of two new oil pools in the vicinity of Wichita Falls. Consolidated Oil No. 1 A Laukhuf, block 5, Cherokee CSL, showed possibilities of a good producer although no official test has been made. The well is in sandy lime at 4415-65 ft. and gushed over the top of the mast after acidization. At the same time oil in commercial quantities was being swabbed from Continental's wildcat, a mile and a half west of Wichita Falls. West No. 1 is in the G. W. Scott survey and picked up sand at 4250-60 ft. It will be put on pump.

▶ **Illinois.** Ohio Fuel Supply Company No. 1 Blanche Nussbaum, 13-2s-6e, brought in a new pool near Wayne City. In 16 hr. 375 bbl. of oil were pumped from McClosky lime.

▶ **Texas.** Deep Rock Oil Corporation No. 1 Morrison has found a new pool in Young County. At a total depth of 4457 ft. in the Mississippi lime, the plug was drilled and the well began flowing oil and gas.

▶ **Texas.** New deep production has been discovered on the east flank of the Humble field, Harris County, where The Texas Company No. 52 Stevenson was completed for 650 bbl. of oil daily. It produces from 5320-35 ft. in Yegua sand.

▶ **Kentucky.** Promise of a good oil pool came to Western Kentucky with the discovery of oil in the Waltersburg and Tar Springs sands at the Blalock and others No. 1 Melton, 8-N-23. The well is drilled to a total depth of 1978 ft. A complete test has not been made.

▶ **Kansas.** An estimated 6533 bbl. of oil daily has been tested in Skelly Oil Company No. 1 Campbell, a wildcat discovery well in SW SE SW 34-24-15w, near Macksville, Stafford County. Production is from lime at 4419-4433 ft.

▶ **Oklahoma.** A Viola lime pool has been opened in Pottawatomie County by the Atlantic Refining Company and J. E. Crosbie, Inc., No. 1 Chilcoat, SE NW SE 10-9-4. A show of oil in the first Wilcox sand failed to develop. Acidizing through perforations between 4508-14 ft. brought in Viola production. After 40 bbl. of oil flowed in 1½ hr., the well was shut in.

▶ **Kansas.** Reno County has a new pool opened by Phillips Petroleum Company, nearly two miles north of the Hilger pool, with production from the Viola lime. No. 1 Manning, SW SW NW 34-25s-4w, was drilled to 4102 ft. and pipe set at 4099 ft. The hole filled 3800 ft. in 3½ hr.

▶ **Louisiana.** A new field in Tensas Parish was indicated after a drill-stem test of Carter Oil Company No. 1 Shelly, 19-11-10. The well, 12 miles north of Lake St. John field, showed oil and gas and 2700 ft. of oil stood in the hole. It was drilled to 8444 ft. in Tuscaloosa formation.

▶ **New Mexico.** A prospective pool opener in the southeast New Mexico sector of the Permian Basin is the C. T. McLaughlin and Cosden Petroleum Corporation No. 1 State, C NW NE 7-17s-33e. The well topped the Grayburg sand at 4170 ft. Gas blew tools up the hole and the well sprayed oil.

AVERAGE CRUDE OIL PRICES

California		Louisiana	
Kettleman Hills	$1.23-1.29	Rodessa	$ .88-1.20
Playa Del Rey	.80- .87	Gulf Coast	.93-1.36
Coalinga	.73-1.13	North Louisiana	.98-1.30
Wilmington	.68-1.24		
Montana	1.00-1.15	Illinois	1.22-1.37
Wyoming	.45-1.15	Kentucky	1.32-1.43
Colorado	1.05-1.07	Indiana	.85-1.25
New Mexico	.70-1.15	Ohio	
Texas		Lima	1.50-1.60
North Central	.97-1.25	Michigan	1.24-1.44
Panhandle	.70-1.12	Pennsylvania	
West Texas	.80-1.27	Bradford	3.00
Gulf Coast	.93-1.48	Southwest	2.65
Darst Creek	1.14	Eureka	2.59
East Texas	.80-1.27	Buckeye	2.30
Talco	.79	Corning	1.31
Kansas	.93-1.25		
Oklahoma	.75-1.25		
Arkansas	.94-1.36		

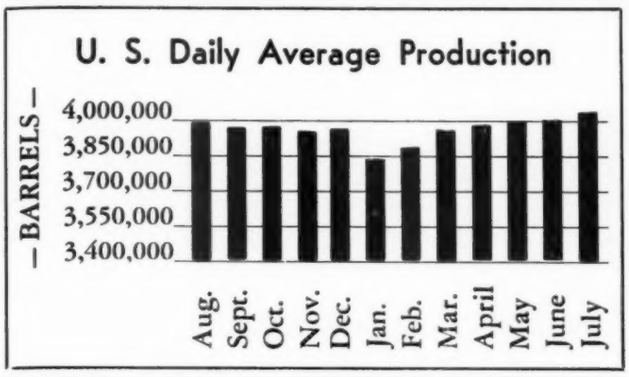
DAILY AVERAGE CRUDE OIL PRODUCTION
Data Supplied by A.P.I.
(Figures in bbl. of 42 gal. each)

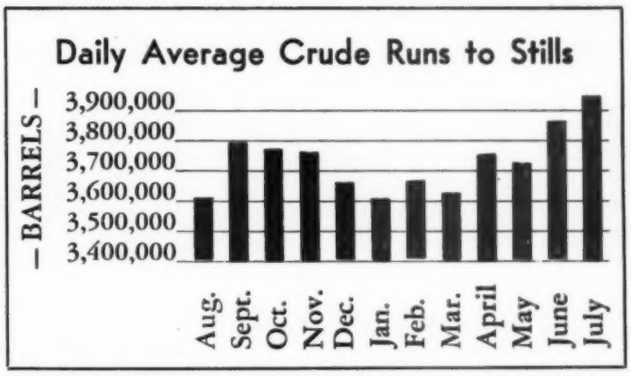
	[1]P.A.W. Recommendations July	Week Ended July 31, 1943	Week Ended June 26, 1943	Week Ended, Aug. 1 1942
Oklahoma	361,400	[2]333,500	[2]339,450	383,400
Kansas	300,000	[2]306,150	[2]306,950	280,050
Nebraska	2,200	[2] 2,200	[2] 2,200	3,500
Panhandle Texas	.....	90,400	90,100	65,800
North Texas	.....	137,700	131,800	139,100
West Texas	.....	245,600	228,950	138,200
East Central Texas	.....	128,000	123,500	74,850
East Texas	.....	371,000	334,900	218,050
Southwest Texas	.....	230 000	208,250	99,100
Coastal Texas	.....	412,900	380,200	171,450
TOTAL TEXAS	1,727,000	1,615,600	1,497,700	906,550
North Louisiana	.....	84,500	84,700	96,200
Coastal Louisiana	.....	264,000	240,850	234,600
TOTAL LA.	331,300	348,500	325,550	330,800
Arkansas	77,200	77,400	75,150	72,500
Mississippi	50,000	53,250	53,100	82,000
Illinois	233,000	218,850	207,750	274,350
Indiana	14,500	13,850	14,500	18,300
Eastern (Not incl. Ill., Ind., Ky.)	88,100	81,050	76,950	91,050
Kentucky	25,000	25,050	19,800	11,500
Michigan	60,100	57,900	54,400	62,500
Wyoming	97,200	100,000	92,000	90,750
Montana	21,800	21,450	20,850	21,650
Colorado	7,000	7,300	6,900	6,800
New Mexico	105,700	103,950	97,150	70,650
TOTAL EAST OF CALIF.	3,501,500	3,366,000	3,190,400	2,706,350
California	827,000	767,300	764,500	676,700
TOTAL U. S.	4,328,500	4,133,300	3,954,900	3,383,050

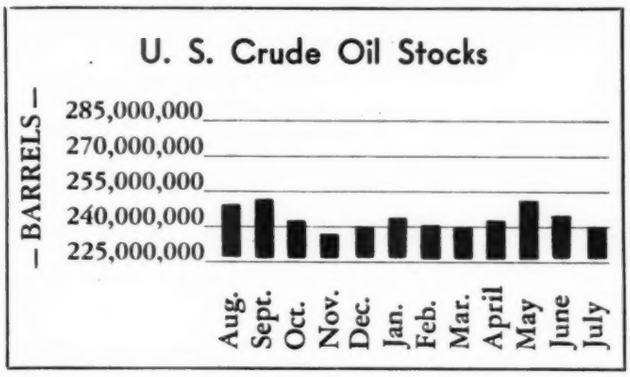
[1]P.A.W. recommendations and state allowables represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Past records of production indicate, however, that certain wells may be incapable of producing the allowables granted, or may be limited by pipe-line proration. Actual state production would, under such conditions, prove to be less than the allowables. The Bureau of Mines reported the daily average production of natural gasoline and allied products in April, 1943, as follows: Oklahoma, 27,400; Kansas, 5,400; Texas, 107,400; Louisiana, 20,000; Arkansas, 2,700; Illinois, 11,200; Eastern (not including Illinois, Indiana or Kentucky) 8,900; Kentucky, 3,200; Michigan, 100; Wyoming 2,300; Montana 300; New Mexico, 5,200; California, 44,900.

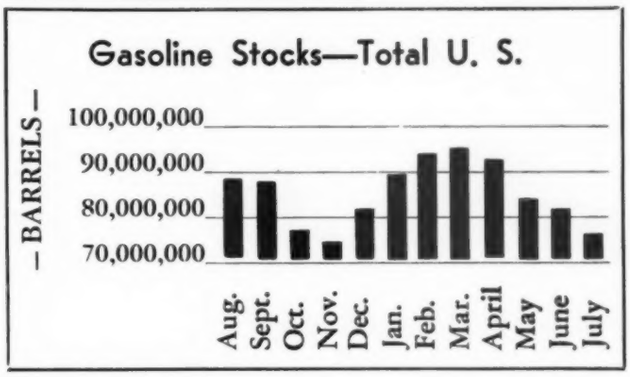
[2]Oklahoma, Kansas, and Nebraska figures are for week ended 7 a. m. July 29, 1943.

PETROLEUM *Statistics* AND FIELD *Operations*









Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for July, 1943

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
Eastern Texas	11	9	5	....	3500-3700	2	40	Rotary
Gaines County	2	2	6	....	4400-5584	2	22-35	Rotary
Hockley County	8	7	4	....	4800-6850	2	20-30	Rotary
Ector County	6	4	4	....	3675-4377	2 or 3	32-36	Rotary
Panhandle	14	11	7	....	1700-3900	2	40	Rot.-Cab.
Nueces County	5	5	3	....	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	5	4	5	....	3730-2935	2	42-43	Rot.-Cab.
Hawkins Field	4	3	2	....	4495-4912	2	19-29	Rotary
Oklahoma								
Okfuskee County	7	7	9	....	2150-4125	2 or 3	38	Rotary
Kansas								
Russell County	8	7	3	....	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	5	3	8	....	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	4	4	4	....	3290-3518	2	39-42	Rot.-Cab.
Illinois								
Central Illinois	161	97	35	108	1425-4100	2	36-38	Rot.-Cab.
New Mexico								
Lea County	6	6	7	....	3150-4030	2	30-34	Rot.-Cab.
California								
Kern County	3	1	3	....	1840-11,450	3 or 4	14-30	Rotary
Wilmington County	5	4	3	....	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for July, 1943

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1942 (In Barrels)
	July	June	July	June	July	June	July	June	July	June	
Arkansas	16	18	12	16	10	12	10	9	16	20	26,560,000
California	95	97	83	88	48	42	36	39	56	51	248,250,000
Illinois	161	150	97	105	54	56	35	27	108	115	105,768,000
Indiana	8	10	5	7	15	21	4	5	4	10	6,680,000
Kansas	143	97	109	81	47	37	22	18	13	15	96,920,000
Kentucky	29	23	20	18	16	12	....	....	....	....	4,503,000
Louisiana	78	90	64	77	18	47	11	12	22	28	125,450,000
Michigan	51	40	37	31	20	18	10	13	....	19	21,568,000
Mississippi	7	5	....	3	....	....	....	....	....	....	27,605,000
Montana	22	20	18	15	....	....	....	6	....	....	8,998,000
Nebraska	2	....	1	....	3	7	....	....	....	....	1,367,000
New Mexico	18	25	14	20	17	14	....	....	....	....	31,875,000
New York	104*	101*	83*	85*	71	56	....	27	....	....	5,132,000
Ohio	89	74	71	67	42	35	....	22	....	....	3,480,000
Oklahoma	111	107	85	92	36	29	18	20	63	61	138,750,000
Pennsylvania	196*	192*	98*	89*	99	108	....	....	....	....	17,256,000
Texas	306	291	226	231	281	298	228	250	286	291	476,560,000
West Virginia	47	45	38	32	24	19	3	4	19	21	3,780,000
Wyoming	8	10	....	8	4	6	1	2	7	19	32,778,000
Total	1491	1395	1061	1065	805	817	378	454	594	650	1,383,280,000

*Includes water-intake and pressure wells.

MAJOR *Pipe Line* ACTIVITIES

THE Federal Power Commission has directed the Cities Service Company, the Cities Service Gas Company, and the Cities Service Transportation and Chemical Company, to show why those companies should not file immediately an appropriate application for a certificate of public convenience and necessity covering construction of a new 240-mile natural gas pipe line. At the hearing, which opened August 11 at Kansas City, the commission said it would investigate whether the companies have acted in good faith and determine if they should be granted a permit.

The pipe line would extend from the Hugoton gas field in Oklahoma and Kansas to Cities Service Oil Company's compressor station at Blackwell, Oklahoma. Priorities to obtain materials for construction of the line were granted by the War Production Board May 24 on condition the companies could get all permits necessary for the project.

Complaints have been filed with the FPC by the State Corporation Commission of Kansas and the Union Gas System, Inc., a Cities Service customer, against the proposed location of the pipe line.

A new 35-mile pipe line will be laid to increase the supply of gas for the Tulsa area by 20,000,000 to 50,000,000 ft. of gas daily, according to Joseph Bowes, president of Oklahoma Natural Gas Company. An agreement has been made to take gas from the newly discovered Lula field of Coal County and materials are on hand for construction of the 35-mile pipe line to the field. The new line will cost approximately $500,000 and will be completed before cold weather.

Hearing on the application of the Hope Natural Gas Company to build a 1400-mile, 22-in. pipe line from Hugoton, Kansas and Oklahoma gas field, to West Virginia, will be held by the Federal Power Commission August 18. The project is planned to take 188,000,000 cu. ft. of gas a day to the East to distribute to factories in and near Kanawha County, West Virginia. Several Kansas and Oklahoma state officials have expressed objection to the line on the theory that West Virginia has plenty of coal and that the two Mid-West states may find their gas resources depleted.

Construction is progressing on the $100,000 improvement project on the Stanolind Pipe Line Company's line between Mexia, Texas, and the Red River. New pumps and engines will be installed at Lakenon, Cresson, Graford and Bowie as soon as the engine rooms are completed. The addition will step up the pumping from 40,000 to 50,000 bbl. of crude oil daily.

Governor Sam Jones of Louisiana has stated that the Tennessee Gas and Transmission Company will have a fight if it attempts to build a natural gas pipe line from southwest Louisiana to near Ashland, Kentucky. The Federal Power Commission has given the project preliminary approval although Louisiana officials oppose the project, contending the state's gas supplies are running low and that the area to be served has adequate power sources in coal deposits in the Appalachian fields. The power commission has set a hearing for September 8 at which time it is said they are ready to authorize the company to build a 20-in. pipe line provided the firm can finance the project, obtain materials, and can fill both the supply and demand in the Kentucky-Tennessee area.

Approval of an amendment to the application of the Stanolind Pipe Line Company permits a second station on the 16-in. line to be laid from West Texas to Drumright, Oklahoma. As a result of this addition the capacity of the carrier will be increased to 65,000 bbl. a day. The station, which will be located south of Hobart, Oklahoma, will contain two electric centrifugal units. Laying of the pipe will not begin before November but ground clearing has already commenced.

Magnolia Pipe Line Company has filed application with the Petroleum Administration for War for permission to lay a 12-in. pipe line paralleling its present 8-in. carrier from Midland in West Texas to Corsicana, Texas.

The proposed line would be 394 miles long and would have three pump stations. It would have a capacity of 42,000 bbl. of oil daily. The line would tie in to Magnolia's main system going to Oklahoma and the Mid-Continent area and connect with the company's principal refinery in Beaumont, Texas. It is estimated that from six to eight months would be required to complete the line.

Oil from the Coke field, Wood County, began flowing last month through the 6-in. pipe line to the Talco Asphalt and Refinery Company, Talco, Texas. The 30-mile line, which has just been completed, will carry 2100 bbl. of oil daily from the Coke field to augment the supply already available from the Talco and Sulphur Bluffs fields. Two large storage tanks have been installed to accommodate the increase in capacity for processing the oil. Oil from the Coke field is low gravity with asphaltic base and is produced from the Paluxy sand.

Work has begun on a 220-mile pipe line to carry refined petroleum products from Chicago to Toledo, Ohio. The Sinclair Refining Company is constructing the line at an estimated cost of $4,500,000. It will cut off 700 miles from the present lake tanker route by which gasoline from the Chicago area moves around the Michigan Peninsula and through the Great Lakes to Buffalo.

The new carrier will deliver 30,000 bbl. of gasoline and light heating oils to Toledo daily. From Toledo the gasoline and oil will be carried by barges and tankers to Buffalo and East Coast points.

Approval by Petroleum Administration for War has been given and completion is scheduled about October 1. Reclaimed pipe will be used principally in the construction. Some of the pipe was taken up in Texas and other states in the Mid-Continent area.

Another line recently completed by the Sinclair company was the petroleum product carrier that was laid from the firm's refinery near Marcus Hook, Pennsylvania, to Steubenville, Ohio, on the Ohio River. A branch line from Marcus Hook to Baltimore has also been finished and is now in use.

A vital part in North African and Sicilian campaigns was played by the new portable steel pipe lines originated by Sidney S. Smith, manager of the Products Pipe Line Department of Shell Oil Company. Several thousand miles of the new flexible line were used in North Africa to carry gasoline and water. The lines varied from 75 to 300 miles in length, keeping pace with advancing troops. The lines have pumping stations at 20-mile intervals and automatic cut-offs so that liquid can begin flowing immediately after a section is laid. Each section weighs 90 lb., has 4 in. diameter, and can carry 25,000 gal. a day.

P 425.233.1

THE Petroleum Engineer

AUGUST, 1943

Direct-Current Rigs for Deep-Drilling Operations

Equipment for use on large full-electric rigs for drilling to depths greater than 11,000 ft.

PART 1

by R. A. J. Dawson

Office of Petroleum Administration for War

In the Reference Annual (July 1) issue of THE PETROLEUM ENGINEER *was published an article by Mr. Dawson on "Construction and Economic Significance of Direct-Current Rigs for Deep Drilling Operations." This paper originally was presented before the Southwestern District American Petroleum Institute Division of Production at Houston, Texas. Since preparing the paper additional data have been compiled on the subject by the author, published herewith and in subsequent issues.*—EDITOR.

R. A. J. DAWSON

is a drilling engineer of Houston, Texas—While attending Rice Institute he was employed during summers by the Institute, The Texas Company, Refining Department, and the Hope Drilling Company—Since graduation as a chemical engineer has worked with Freeport Sulphur Company, The Texas Company, Production Department, Gulf Oil Company, Producing Division, Stanolind Oil and Gas Company, Strake Petroleum, Inc., and O. W. Dyer, Sr. and Jr., drilling contractors—Now employed by the Production Division of the Petroleum Administration for War, being assigned to the Materials Division in Washington, D. C.

Prime Movers

AT THE present time there are several makes of slow-speed, 4-cycle Diesels that are convertible to gaseous fuels without seriously impairing their efficiency. None of the gasoline engines of high horsepower ratings is convertible without serious power losses.

It seems that new conversion design will enable the heavy, slow-speed, 2-cycle marine Diesels to develop up to 75 percent more horsepower through the use of special poppet-valve type heads. These heads will bring about gas injection during almost the entire downward power stroke, and the continuous combustion will add greatly to the torque while the speed remains constant.

Regardless of what type of power is used the load should always be divided equally between the prime movers, which should be at least three in number, each being of from 330 to 500 b.hp. With triple units of this kind sufficient power is available to drill with two engines, and the drill pipe may be withdrawn from the hole by a single engine if the well is not deeper than 11,000 ft.

Each motor should have enclosed friction power-takeoff of modern design preferably of the double twin disk type that is so readily adjusted for clutch wear. Integral radiators are to be installed if possible in order to do away with the troublesome bulk of complicated cooling towers. Radiators are now designed that can handle 350-hp. Diesels, and there is no reason why they cannot be further developed to more efficient larger sizes. Radiator fans should always be constructed in a manner to blow the air blast through the radiator and away from the power takeoff end, as this will add greatly to the ease of maintenance and repair of the engines and generators.

Many Diesels are air started, and the necessary compressors and tankage for this operation must, of course, be provided. Almost all gas and gasoline engines of large size, and some of the Diesels, use small starting engines, of which there should be at least one standby, as they are so easily damaged.

Available oil-field prime movers range in speed from 400 to 1200 r.p.m., with their weights being in approximately inverse ratio. As portability and dependability are both of extreme importance, much thought of future locations should be exercised before selection of type is made. Barge setups are well designed with the simpler, heavy, slow-speed engines, but portability needed for land operations has encouraged the use of the lighter, high-speed machines.

It is only during the last six or seven years that light, complex, high-speed engines have been used with any marked success; however, their steadily improved design and more careful field handling are demonstrating their ability to perform heavy-duty drilling.

It is interesting to note that a large, well-known 900-r.p.m. gas engine was originally designed to turn at about 1200 r.p.m., but it failed to stand up to the planned speed. It was planned to use

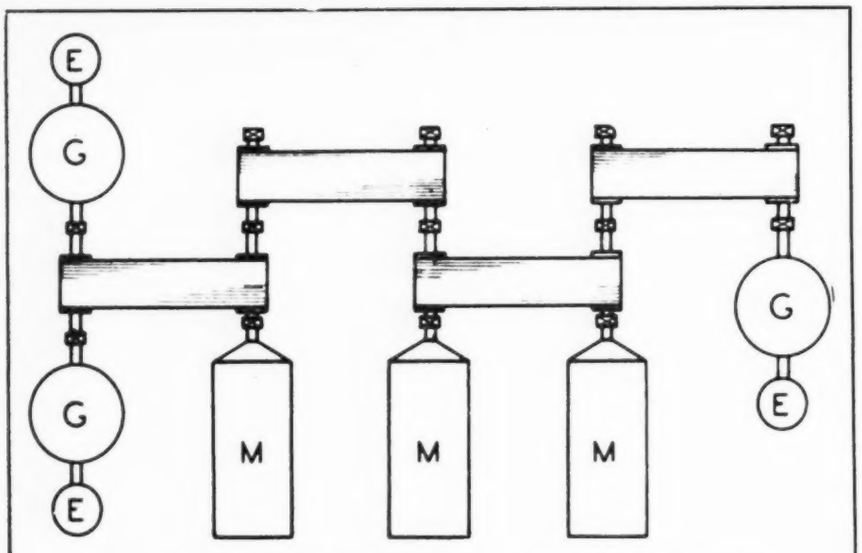


Fig. 1. Transmission diagram for three engines, three generators, and three exciters

this large engine for direct connection to large 1200-r.p.m. generating units to make a heavy-duty power plant having several important features.

Diesel engines of modified pressure scavenging 2-cycle design are now being used for military marine service, giving about 500 hp. at about 1200 r.p.m. These engines should be ideal for direct connective use in oil-field power plants because of their high horsepower output per pound of weight. They are constructed by a well-known automobile manufacturer, and should, along with other recently designed high-speed Diesels, revolutionize oil-field power plants.

In-line plants have been used for some time with shallow drilling rigs and the new high-speed Diesels will provide sufficient power to do deep drilling. It will be possible to use the accurate construction facilities of the large factories in assembling these large in-line plants, resulting in units of better bearing and shafting alignment. Moving and rig-up time should be greatly reduced, and the overall efficiency of the power plants greatly increased.

The slow-speed Diesels, turning at about 400 r.p.m., are generally only slightly different from the basic marine-type engines. These heavy engines are very dependable, having low upkeep cost and high load-lugging characteristics that enable them to take high overloads without damage. More than 11,000 ft. of 4½-in. 16.60-lb. drill pipe has been pulled by a single 265-hp., slow-speed marine Diesel driving a 250-kw. generator that in turn drove a 300-hp. electric motor. It is impossible to perform such overload feats with high-speed Diesel engines, which are also somewhat more difficult to maintain and have higher upkeep costs.

It will be much harder for a direct-drive power rig to use high-speed engines than it will be for a full-electric, d-c. rig to follow the high-speed trend. Clutching troubles will naturally increase at high speed, and it is impossible to obtain full engine power unless the motors are up to rated speed. Until torque converters and hydraulic transmissions are made much larger and more efficient, direct-drive rigs will not have the necessary smooth power conversion to do competitive deep drilling.

Until it is necessary to run the power plant at full rated speed, full-electric rigs can loaf along at about half or three-quarter prime mover speed, thus saving engines from much wear and reducing fuel consumption. It is often possible to overhaul the engines by turns in surface hole, by shutting down one engine at a time and running on the full-speed power of the other two.

The difference in weight of the Diesels suitable for oil-field use is interesting, for a well-known, 6-cylinder, 265-kw., marine Diesel weighs more than 25,000 lb. with its accessories, as contrasted with the 11,000 lb. weight of a new pump scavenging, 500-kw., 1400 r.p.m. machine. Both are 2-cycle engines, but the marine type has the old crankcase scavenging system.

For quite some time both Diesel and semi-Diesel high-speed engines have been built on the 4-cycle principle, but the new higher-speed machines use both the 2-cycle design and pressure scavenging to increase greatly horsepower output per pound of weight.

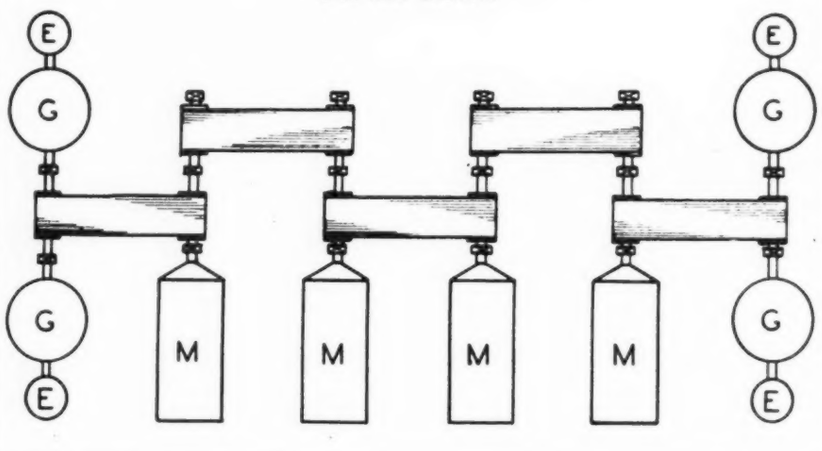
Available Diesels range in speed from 400 to 1000 r.p.m., and gasoline engines of comparative output from 750 to 1200 r.p.m. As most of the generative equipment available for oil-field use rotates at 1200 r.p.m., the engines must not only be teamed together, but their speed must be increased to 1200 r.p.m. in order to get full efficiency from the generators.

Power Plant Unitization

If three motors are used a 6-pulley V-belt transmission should be fabricated with each motor carrying two sheaves on its base extension as indicated in Fig. 1. Three keyed sheaves and three jaw-clutched-faced spool sheaves should be used in order to be able to coördinate stoppage and power requirements.

Idlers should be made integral with the motor skids, which practice will save realigning the idlers and pulleys on each rig move. Idlers can be best unitized at the factory because a more compact and accurate setup can be made with the better machine tool facilities available. The generative unit skids do not require idlers, and the belts can be kept tight by pushing these

Fig. 2. Transmission diagram for four engines, four generators, and four exciters



units away from the motor skids by means of large turnbuckles.

Foundation skids are usually fabricated from 8-in. by 12-in. I-beams in order to provide a sturdy, vibration-free base for the power plant. If the plant is properly laid out two 8-ft. by 35-ft. by 12-in. skids are sufficient, the engine and generative units resting crosswise on the foundation beams.

The diameter of the sheaves and the number, length, and size of the V-belts needed can be determined for both the proper loading and the relative speed of the rotative units. In transmissions of this type the D-section V-belts are generally used, with E-section a secondary choice.

It is absolutely essential that the motors themselves have a friction power-takeoff, but the use of friction clutches in transmissions is not generally of such advantage as to pay for the higher investment and the frequent failure, renewal of linings, etc. Jaw clutches are sufficient for transmission service and need very little attention, being so simple their field repair is easily accomplished.

D-C. Generator Characteristics

The inherent protective power characteristics of "drooping voltage" machines are well illustrated in the percentage characteristic curves shown in Fig. 4. As the amperage increases (with increasing load) the power output rises to a maximum at about 110 percent of full load amperage. Beyond this value the power decreases (along with the drooping voltage), and although it is possible to pull stalling torques (amperages) of more than three times normal, the prime movers cannot be overloaded or stalled. With such control, high torque starting, smooth acceleration, and cushioned shock distribution are efficiently accomplished.

The power plant is designed so that the total peak generator output does not exceed the total maximum capacity of the engines and the electric driving motors can be stalled without slowing the engines to any appreciable degree.

As the sum total of the currents (torques) of the electric driving motors is also dependent upon the generator characteristics, these torques can be limited by design to a safe value from both an electrical and mechanical equipment standpoint.

By initial adjustment of generator fields the complete protection of prime movers, generators, and driving motors is made automatic, regardless of load fluctuation.

"Percentage" characteristic curves of the type shown are used by various manufacturers to illustrate the behavior of a type of machine, and by using suitable factors the performance of machines of different ratings can be predicted. In large electric rig construction all equipment must be of the same voltage in order to insure flexibility and provide for emergency substitution.

Factors for a 350-volt, 330-kw. generator and a 350-volt, 400-hp. driving motor would be extended as follows:

Kw. rating of generator	× 2.86 =	100 percent generator amp.
Hp. rating of motor	× 2.36 =	100 percent motor amp.
Hp. rating of motor	× 5.25 =	100 percent motor torques.
330	× 2.86 =	944 amp. for generator.
400	× 2.36 =	944 amp. for motor.
400	× 5.25 =	2100 ft-lb. motor torque.

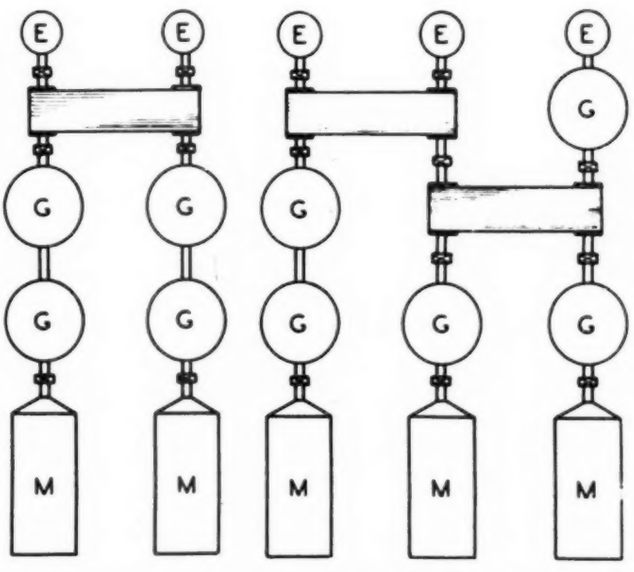
By substitution of the above values at the 100 percent points on the percentage curves the intervening values may be extrapolated. This method will give approximate results for any size machine of the same make and type.

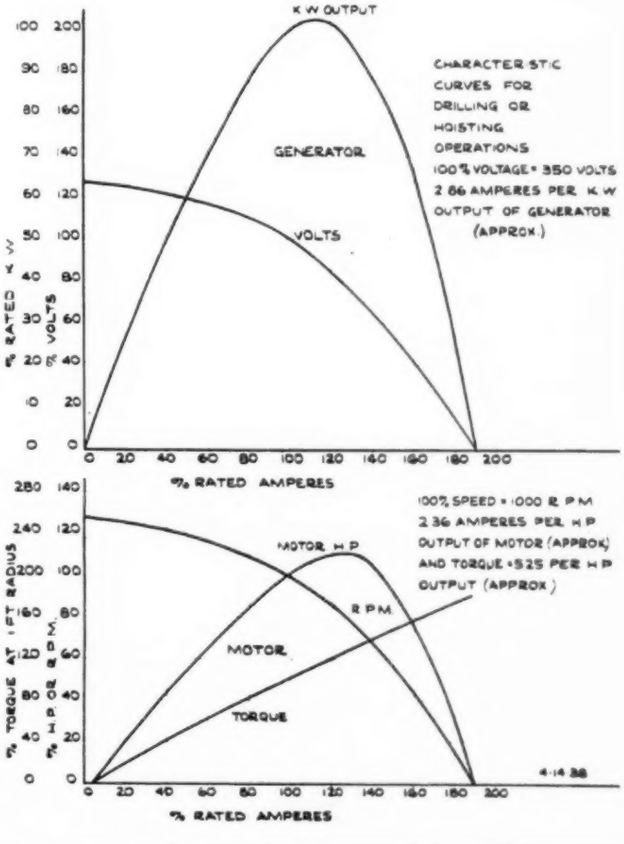
The torque of a d-c. motor is almost proportional to the armature current, and the fundamental design of the rig must be built around the ultimate torque that the electric motors will have to deliver.

The power output, or time rate of

Fig. 3 (Below). In-line transmission types of design

Fig. 4 (Right). Characteristic curve of d-c. generator and d-c. motor





doing work, is the product of the voltage times the amperage; hence, inasmuch as the voltage is directly proportional to speed, the need of high-voltage generators to get sufficient speed into the motors (when possible) is easily seen.

The elementary electrical equations governing the above relations are as follows:

Power in watts =

$$W = E \times I$$

power = volts × amp.

$$E = R \times I$$

volts = res. × amp.

Heat loss (power) in watts =

$$Heat = R \times I^2$$

watts = res. × amp.

E (voltage) is proportional to speed (r.p.m.)

I (amperage) is proportional to torque.

In the case of underpowered electric rig the above relations establish inefficient operating conditions. As additional load is imposed, the needed torque to carry this load increases, and as the torque is proportional to the armature current, the rising current in the series field of the generator opposes the other small current generator fields protectively decreasing the voltage and the speed to an impracticable value.

Power transmission to the electric driving motors is efficient and the "line drop" in voltage is low except at high amperages when it reaches a maximum of 10 to 15 percent of full no-load voltage. Power losses due to heating effect are equal to the resistance of the circuit times the square of the armature current, but this effect is not to be confused with the designed decrease in generator output at high current rates.

Compounded Generators

As stated before, compounding of generators is not recommended because machines of sufficient size should be procured in order to be able easily to handle their respective duties without other generative aid. Behavior of compounded machines is discussed because some electric rigs are still being designed using compounding principles that are not fully suitable for deeper operations.

If small compounded generators are to be used the delegation of work to these units makes the power armature circuits more complex, and as usually applied with small separate engine-generator units, results in unequal load distribution between prime movers. Even if an engine transmission is used, no advantages are procured from generator compounding as compared with a sufficient number of larger generators that need much less complex control.

For smaller electric rigs the use of small mobile engine-generator compounded units is still feasible, but small internal-combustion engines are impracticable and less economical upon large rigs. For deep operations the paramount result to be accomplished is the balanced concentration of the brutish power of any or all engines into any or all generators that each in turn are able to supply any driving motor.

The natural tendency of electrical manufacturers to introduce complex features such as compounding, master switches, and other complex control has handicapped development of deep competitive electric drilling because of the inability of the drilling industry to appreciate quickly and properly care for such involved and expensive features.

Parallel Compounding

Direct-current generators have been widely and successfully operated in parallel on smaller rigs and this system of compounding is much more applicable to drilling operations than series compounding. By compounding in parallel, designers have been able to use the constant maximum voltage (speed) feature to impart desirable rig speed characteristics with additional paralleled generative capacity being added later without changing basic rig speed relationships.

While the maximum voltage remains constant the output and hence motor torque varies almost directly in proportion to the total capacity that is paralleled. Reference to Fig. 5 illustrates the speed (voltage)-torque (current) characteristics of a motor operating on one, two, three, and four generators in parallel.

Generators are so designed that when operated in parallel they will not attempt to reverse rotation in case of failure of driving mechanism. In such failures the generator will run as a motor in the same direction, drawing power from its twinned generators without resulting damage.

Two or more d-c. generators of different rating but identical voltage may be operated in parallel to drive pump or hoist motors. Such paralleled machines must both have "drooping voltage" characteristics in order to be able to divide the load in proportion to their ratings.

Series Compounding

In series compounding the maximum current is constant and each compounded generator adds its voltage to the total to increase the speed in direct proportion. Such inherent speed fluctuations are not very applicable to drilling methods and as a result series compounding has not found widespread favor. The speed-torque characteristics of a motor operating on a single generator and upon two series compounded generators are shown in Fig. 6.

(To Be Continued)

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Fig. 5. Characteristics of d-c. motor operating on parallel generators

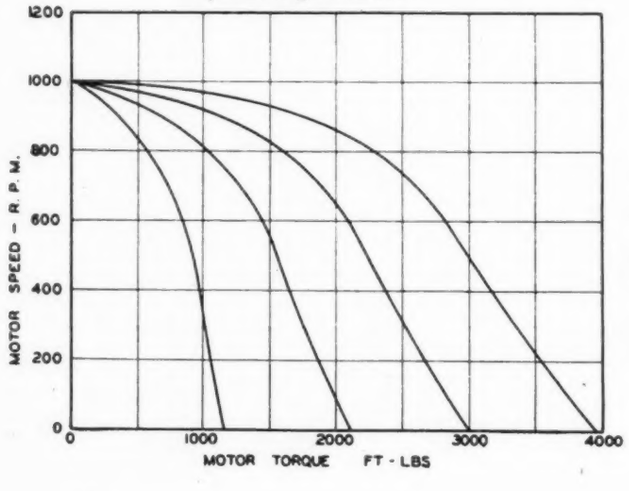
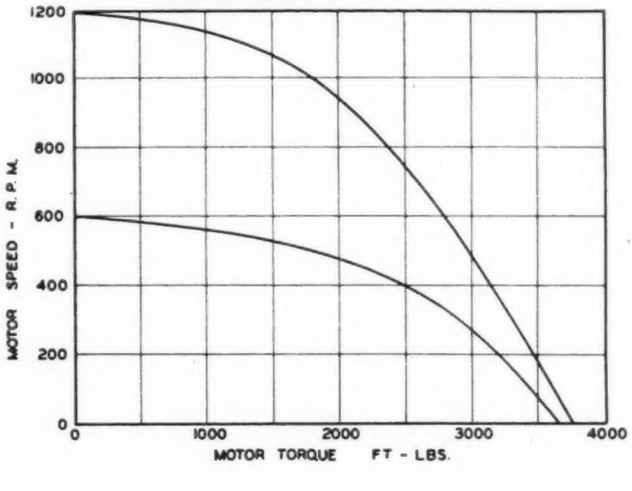
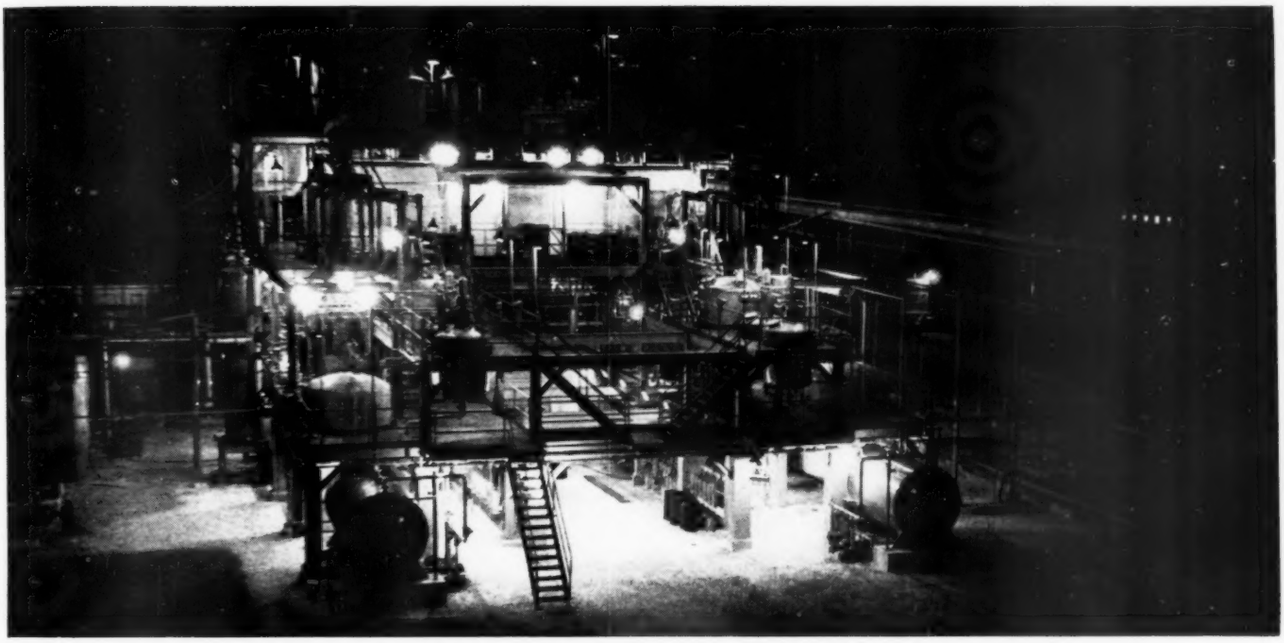


Fig. 6. Characteristics of d-c. motor operating on series compounded generators





In this unit of Monsanto Chemical Company's new plant the alkylation of ethyl benzene processing begins

Styrene Plant Placed in Operation

Petroleum Engineer Exclusive

☆ **Essential raw material for manufacture of Buna S rubber produced from ethylene gas and benzene**

by C. C. Pryor, **Associate Editor**

IN SEVEN days less than one year the Monsanto Chemical Company completed construction in the Texas Gulf Coast area of a plant for the production of styrene—essential raw material for the manufacture of Buna S synthetic rubber. Basic construction of the plant began March 17, 1942, and the first tank car of styrene left for Ohio March 10, 1943. In the Goodyear Tire and Rubber Company polymerization plant the styrene was combined with three times the amount of butadiene from the West Virginia plant of Carbide and Carbon Chemicals Corporation. Several days later the first synthetic rubber jeep tire was fabricated and delivered to Rubber Director W. M. Jeffers in his office in Washington.

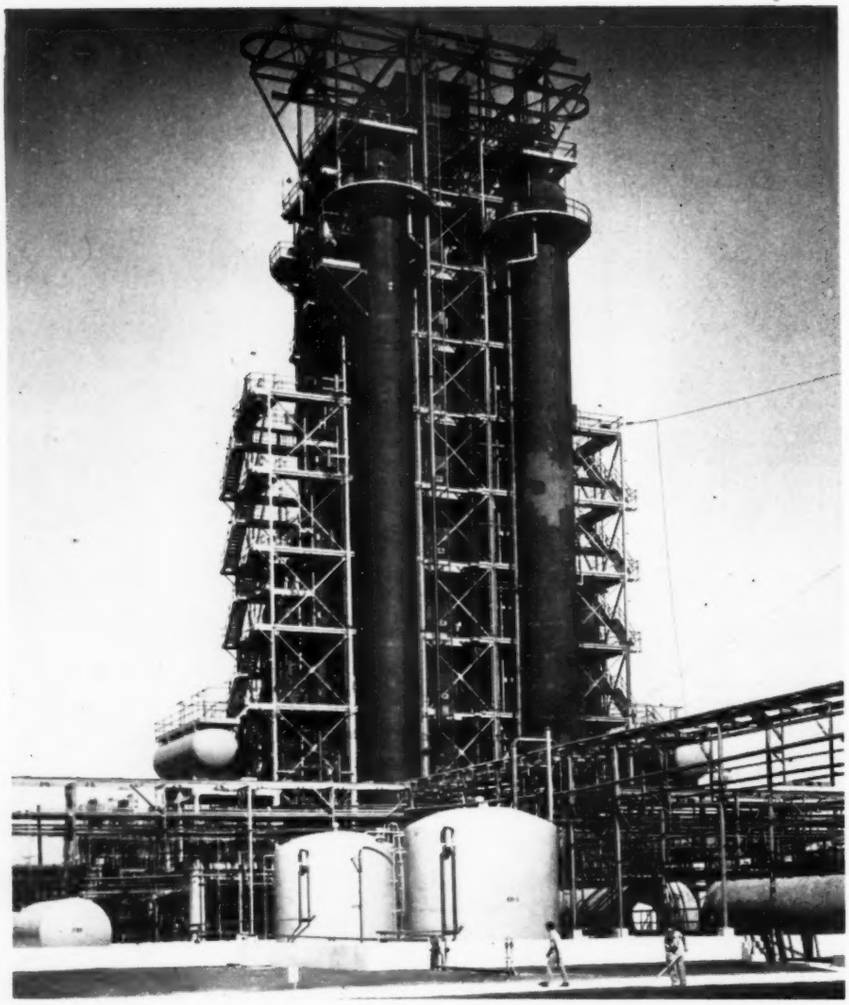
Styrene for the manufacture of plastics had interested Monsanto a number of years previously and the company began marketing a styrene-base plastic in 1938. Intensive research initiated in 1939 at its Central Research Laboratories in Dayton, Ohio, resulted in a process for styrene production. In the Gulf Coast plant styrene is produced from ethylene gas and benzene, both materials being obtained from outside sources at present, although the plant is preparing to produce its own ethylene. The ethylene is produced by a cracking process similar to methods used in the petroleum refining industry from propane and the benzene is obtained from coke oven gases. Then the ethylene and benzene pass through alkylation units for conversion to ethylbenzene. As styrene differs from ethylbenzene by having two less hydrogen atoms, ethylbenzene is converted to styrene by a dehydrogenation unit, which removes the hydrogen atoms.

"An aromatic hydrocarbon compound having a double bond," is the description given styrene by chemists. The key to the usefulness of styrene is the double bond in plastics and synthetic rubber, as these bonds enable individual molecules of the compound to be "linked" or "hooked" together into long chains. Hooking the molecules together is termed polymerization and radically changes the appearance and the physical and chemical properties of the material. Polymerization of styrene alone changes it from a clear-white liquid to a hard, dense glass-like substance. Polymerization of styrene and butadiene together in the correct proportions results in Buna S rubber.

An agreement was completed between Monsanto and the Rubber Reserve Company in November, 1941. A site was selected on property formerly occupied by sugar refinery buildings. This location is near the sources of raw materials; some facilities on the property could be rehabilitated for use, and the waterfront location supplied unlimited quantities of cooling water, necessary in the process. Before piling could be driven, part of the plant site covering 13½ acres was filled in with material dredged from a nearby bay.

Construction of the plant required 13,250 tons of steel and iron, 290 tons of copper and alloys, 260 tons of alloy steel, and 16 tons of nickel alloys. Twenty percent of the plant is underground.

Information concerning the plant released by government censorship includes the major unit of the plant, the distillation tower, which is equivalent to a 20-story office building. The water pumping unit of the plant is capable of pumping 35,000 gal. per min. of water, which is sufficient to supply a city of 500,000 inhabitants. The plant is lighted in such a manner that the crew of an airplane passing overhead is unable to see it, yet from the ground the lighting is a brilliant spectacle. Complete blackout can be effected in 60 seconds and still the plant can remain in full operation, in event of at-



Reaching into the sky 20 stories above ground level is this distillation tower, essential unit of the styrene plant

tack by enemy planes or submarines.

Construction of the plant involved numerous complications and difficulties. Highly technical in design and operation, basic style of the plant is the refinery type of construction and employs explosion-proof electrical equipment throughout as well as advanced types of control instruments.

From the beginning, the project was recognized as a large one, but it was impossible to anticipate developments that took place after construction began. Size of the plant was increased or altered steadily from January until August, 1942, which presented a constant stream of new problems to the engineering organization. The main difficulty encountered was the closeness with which construction crowded design. This was not a plant that could go from the laboratory design stage to working pilot plant stage and then increase in geometric proportions as the design was improved and "bugs" were removed. It was required that large scale production be the first step after the laboratory and construction of the plant. Some idea of the vastness of the project is obtained from the fact that the styrene produced by the plant combined with three times as much butadiene from other sources, would supply the amount of rubber that normally would be produced from 60,000,000 rubber trees, on 600,000 acres of land.

Before working drawings were begun, capacity of the plant was set at 3000 tons per year. Changes in design to increase capacity were rapid, rising from 3000 to 6400 tons, then to 10,000 tons. In January, 1942, capacity was revised upward to 20,000 tons, in April to 40,000 tons, and finally, in September to 50,000 tons. In full operation a substantial part of the styrene produced in the United States for Buna S rubber will be produced in the plant.

Information and photographs for this article were supplied by the Monsanto Chemical Company and were released for publication by the Bureau of Public Relations of the War Department, the Defense Plant Corporation, and the War Production Board.

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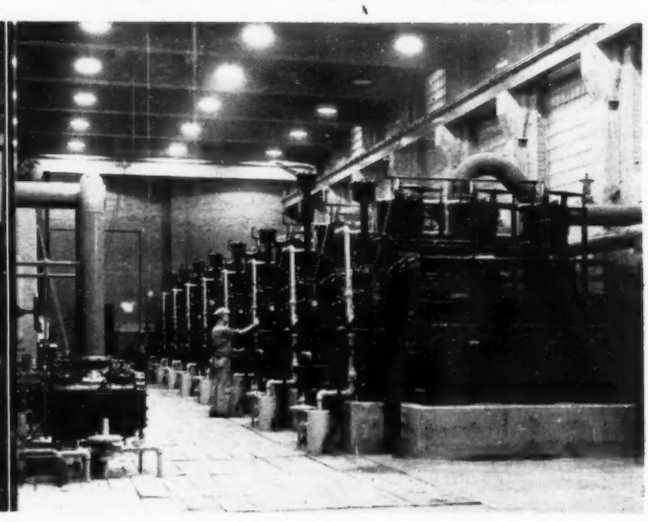
Control room where the most minute operation is recorded and adjustments made in the manufacture of styrene

The water pumps supply 35,000 gal. per min., equivalent to the requirements of a city of 500,000 population



PETROLEUM ENGINEER Exclusive Feature

Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Manufacture of Lubricating Oils

Class Meeting No. 10 (Continued)

NOTE: Throughout the class proceedings, no attempt is made to distinguish the identity of the pupil speaking. When a series of remarks is made by pupils it usually denotes an interchange of discussion among the class members themselves.

Pupil: We were discussing hydrodynamic lubrication.

Pupil: Yes, and as was said, we have two surfaces AB and CD (Fig. 23), and we draw planes vertically shown by dotted lines through those two surfaces and pump oil into this side and put pressure F on AB. This is one body of oil. As that pressure is increased, the oil lines will tend to deform as between A^1B^1 and CD. The components of all those little forces will be pushing against the plates of oil and will be pumping out the side. That force, of course, becomes very great at times.

Leader: Capillary force or surface tension?

Pupil: That explains the reason you are forcing the oil in there.

Pupil: In fluid friction, you are forcing the oil in and the actual opposition to the shearing stress is the force that pushes it up.

Leader: Sort of a wedging action?

Pupil: Yes, the actual viscosity of the oil holds the plates. It is the force inside the oil. This force has been connected with the force required to tear the molecules apart. That was illustrated as not being the case at all, as water flows very freely and it took 360,000 lb. per sq. in. of pressure to pull the molecules apart when actually it is a very fluid material; then you can go on forcing this oil between inclined plates; where the distance between the plates vary (as in Fig. 24), your forces go into something like this and EAC is all the oil that comes out, whereas you are actually pushing in FBD. The rest of it has to come out at right angles to that plane. The component of the force tends to come over in AGB shape. You have your bearing rotating in oil and you have the same thing going on in your bearing. We can go back to Fig. 20 and find that that holds true. If you increase the speed of rotation of that bearing, you increase the

$$\frac{ZN}{P}$$

The greater the viscosity and the greater the speed, the more oil film will be forced in between the metal surface.

Pupil: The greater the pressure, the less it will be forced to move?

Pupil: Yes.

Pupil: If you have too heavy an oil, it will not run at all?

Pupil: That is true.

Leader: Is the cohesive power of the oil so great that it will fail to penetrate in sufficient quantities to provide lubrication?

Pupil: Yes. I read quite a discussion on internal combustion.

Pupil: I want to ask if you can have boundary lubrication in a condition like that?

Pupil: Yes.

Pupil: I thought boundary lubrication could only exist between two immobile parts.

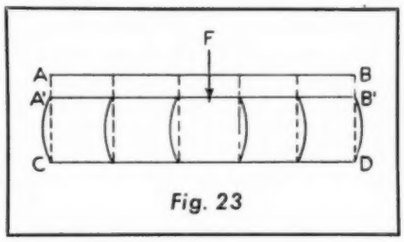


Fig. 23

Pupil: If you raise the pressure up to 12,000 lb. per sq. in., you will have boundary lubrication.

Pupil: If your surfaces are not moving, you don't need boundary lubrication anyway.

Pupil: Perhaps if you would re-define fluid lubrication and boundary lubrication, it would be clear.

Pupil: All right (reads definition).

"Boundary friction * * * including: (1) dry or solid friction, which occurs between perfectly clean, dry, solid surfaces; and (2) thin fluid friction, which occurs between solid surfaces partially or completely separated by a film of fluid so thin that the unknown intermolecular forces between the fluid and solid surfaces determine the character of the frictional resistance."

Boundary friction could be anything less than fluid friction.

Pupil: You get seizure on these wear-test machines. You have perfect lubrication; I don't see why you have seizure.

Leader: This is a discussion on normal machinery.

Pupil: I don't see why you get seizure with perfect lubrication.

Pupil: If you don't have the right lubrication, the right weight, you are going to have a film break-down.

Pupil: Anytime you get past the fluid stage—that was the general idea I got.

Pupil: You don't have any friction in a motionless stage.

Pupil: Let us define "motionless." We have here a motionless block and a motionless plane and we are feeding a lubricant between them and this lubricant is moving. That is not, in my opinion, a motionless existence, because this lubricant might as well be stationary and the bearings keep moving. When this all becomes motionless, unless the bath holds the lubricant in place, it is going to flow away and the block is going to come to rest on the plane, and then you will have boundary conditions unless you have this filled with sorghum or something strong enough that it will not flow away. Does that help any?

Pupil: Do you think they approach that boundary lubrication in any machinery?

Pupil: All automotive engines approach it, and every time you start or stop your car you have boundary lubrication.

Pupil: In boundary lubrication, I should think that time would be the most important factor. If you give the oil time enough to flow away, then you have a boundary lubrication.

Pupil: If your oil is still flowing, it is not motionless.

Pupil: If you don't have boundary lubrication, why is it the petroleum industry spent millions of dollars developing a hypoid gear lube?

Pupil: Hypoid gears could not be lubricated with a mineral oil.

Pupil: Someone asked what viscosity oil would be required for the internal-combustion engine, and why, if any, additive agents should be used. I don't remember, but if somebody wants to

ask some questions, maybe I can remember enough to answer. It is indicated that in a piston operating in a cylinder block between the cylinder walls and the piston, there is not much pressure, and an oil must be used that when it gets into the combustion chamber it will be carried away without forming any more carbon than is necessary. It is impossible to keep that oil out of the combustion chamber because of the operation of the piston in the block, and it is indicated that the maximum pressure on the piston wall would be about 15 lb. The average piston pressure during a complete cycle is about 275 lb. per sq. in. exerted on the block, but the velocity is high, I believe 1000 ft. per second. That helps the lubrication and keeps the oil film between the metal surfaces and permits the use of a low viscosity oil.

Pupil: Isn't the pressure zero at the end of each stroke?

Pupil: Yes, but you have to take an average on that.

Pupil: Did the articles you read indicate that the application of lubrication —bearings and internal-combustion was constant—that you could design the lubricant to get the advantage of boundary lubrication?

Pupil: It fluctuates. The pressure is high at one point and then the reverse.

Pupil: Peak loads are designed so you will not get any boundary lubrication at the peak.

Pupil: There was one interesting thing I found: On your bearings, say this is your main bearing and you have your connecting rod coming out here. This is your top load, which we will call the maximum pressure approximately at that point. On your bearings tests failure has never been at this point, but always at the point of reversal.

Pupil: That is due to the velocity.

Pupil: Is it maximum or minimum at that point?

Pupil: Minimum.

Pupil: Minimum velocity and pressure also.

Pupil: Minimum pressure, but I don't know—I did not quite understand just why that would be true. Do you know why that would happen? Why failure would always be at this point of reversal?

Leader: Are we talking about connecting rod bearings?

Pupil: Yes.

Leader: No, I don't know why it is.

Pupil: I would not know unless all the fluid has flowed away from the bottom bearing because there is no velocity. Any other questions? From the information available, it was indicated that an oil with as low viscosity as possible should be used in internal-combustion engines and that narrow cuts were best.

Pupil: Does the oil subjected to pressure become a plastic? When the oil is compressed down to minimum thickness on the surface of the metal, one millionth of an inch, does it lose its bulk when it becomes that thin?

Pupil: I don't know. I do not believe that an oil recommended for internal-combustion engines having as low viscosity as will do the job, and a maximum pressure as high as 3000 lb. per sq. in. on a piston, would be compressed into a plastic. I think they would be tied to the metal surface due to pressure so that they probably would not wipe off very easily.

Pupil: You can't compress any lubricant into a solid.

Pupil: Is a plastic a solid?

Pupil: Yes.

Pupil: Does an oil lose its oiliness throughout?

Pupil: As we know, the animal and vegetable fats have much greater lubricating value than any mineral oil; their

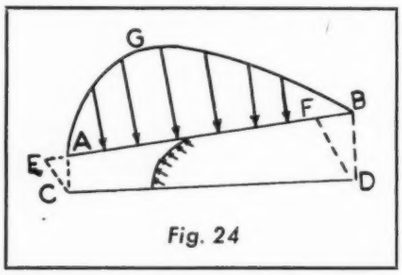


Fig. 24

objection is their instability. They might become unstable after they have been used, but so far as the actual molecules of mineral oil having the same oiliness, I believe they have; however, if you change the chemical structure, you might have some plastic.

Leader: We have had two conflicting statements. One of those was that the oiliness did not count until you approached the point of failure in lubrication; that what was actually controlling the oiliness was the internal friction of the oil. The other statement is that oiliness is the unexplained difference between the friction factors of two or more oils whose viscosities are the same. That presents two schools of thought. I thought if anybody believed in it implicitly we might arrange a debate.

Pupil: I don't believe that those two statements are conflicting. The difference would be much greater when you get down to facts. You said it was the difference between the friction expected and the friction obtained.

Leader: The view was taken that with moderate lubricating conditions, oiliness is not involved in making better performance. We are talking about a typical oil that has been produced. Is that essentially one of the viewpoints?

Pupil: So long as you have fluid lubrication, oiliness has nothing to do with it.

Leader: Perhaps the maximum pressure would be on the rod bearing. Does it always have fluid lubrication?

Pupil: Good lubrication does not depend on oiliness but on viscosity and viscosity is the friction that the oil has in the fluid?

Leader: There is quite a difference of opinion on that subject. One company has been criticized by executives of other oil companies for maintaining that an oiliness agent was needed.

Leader: English writers agree that oiliness does not enter into the picture until the point of failure is reached. In ordinary lubrication, that point would not be reached.

Pupil: The idea I got was that the oiliness of an oil was its ability to cover and adhere to the surface—the wetting ability. Additive agents are for that purpose.

Class Meeting No. 11

Leader: The announced subject for this meeting, as we wrote it out several months ago, is as follows: Lubricating problems faced by consumers, review of compounded oils not previously discussed, and what shall the manufacturer do to improve oils. We talked about that some at the last meeting and about service requirements and what the consumer problem was in regard to the automobile engine. We talked about automotive engines and all that we said referred not only to gasoline engines but also to Diesel engines; however, Diesel engines have a special problem and each one of these is worthy of many hours study, therefore it will only be possible to mention the subject briefly. The compression ratios of about 7 in gasoline engines increase to something like 16 to 17, or even more in a Diesel engine. That suggests heat and more heat and greater pressure, so all that we have said concerning automotive engines is emphasized in the case of Diesel engines. Therefore, these additive agents certainly would seem necessary for Diesel engines. Then there is still another characteristic that we did not discuss, and that is the characteristic of detergency; it is that characteristic of being able to remove foul substances and to carry solids in suspension in colloidal form. There are some metallic compounds that have been developed for Diesel engines and are used as addition agents. The question is asked, "Why do we need these in Diesel engines and not in gasoline engines?" Some people think we need these in gasoline engines such as buses and trucks. As mentioned, in the case of Diesel engines there is not only the

problem of decomposition, but also the problem of heavy ends from the fuel, which probably quite often will be in a solid condition. The need for detergency is admitted, therefore, and is being taken care of by addition agents in Diesel engines. We will pass on unless some of you wish to add some comments.

Pupil: Is it a fact that an oil is used considerably longer without changing in Diesel engines than in gasoline engines?

Leader: I don't remember.

Pupil: I was talking with an engineer of a light plant where Diesel engines are used and he said some of the oil they are recycling has been in use for as long as three years, with a turnover about once every three years.

Pupil: It was my understanding that he said they just kept on using it and put in a cotton waste filter.

They add to it every few months, but it takes three years to handle a complete turnover. They send it in for analysis every two or three months.

Leader: Any other comments on Diesel engines? That is a very interesting point; however, you also realize that in the case of large stationary engines, oil, gasoline, etc., some have reclamation systems also.

Pupil: My question was in regard to a comparable automobile engine.

Leader: I do not believe there is any particular difference in the length of service.

Pupil: What are the samples checked for and what do they show?

Pupil: The samples are compared with new oil.

Pupil: Undoubtedly the acidity increases.

Pupil: It would have to be a rigid test before much could be determined. If an oil could be run three years, that would seem to substantiate the theory that oil does not wear out but is only contaminated.

Pupil: Looks as though it would depend on the amount of wear on the bearings and equipment.

Leader: How would you determine that?

Pupil: You might shut the engine down.

Pupil: It would be easier to check the oil.

Pupil: I know of one case of natural gas engines that operated continuously, oiled by a drip system where recovered oil had been used for years and was run through a filter, but they never did throw the oil away. They operated the engines on a large scale with very little trouble.

Leader: I have attended S.A.E. meetings where fleet operators stated they had engines which had operated from two to three years and all they did was add oil.

Pupil: They could run dilution tests and viscosities and tests of that nature, and if they came out comparable to what the new oil was, it would be all right.

Pupil: Maybe it does not wear out—does it?

Pupil: What is meant by "wearing out?"

Pupil: In some of these service tests they run the oil until the acidity builds up and the oil is unfit for use.

Pupil: They filter it through Fuller's Earth and keep the viscosity down.

Pupil: If the oil is decomposing, the viscosity of the oil would increase if dilution had taken care of that factor.

Leader: Oil doesn't wear out but chemical changes make it desirable to remove it.

Pupil: I don't think the question of wearing out is very difficult.

Leader: Apparently this thickening is due to the production of resins and resins are very undesirable.

Pupil: You can call them varnishes.

Leader: These oils, when they become thick, often do not drain from the crankcase.

Leader: About 1926 one company took the initiative in developing a rear axle drive assembly that at that time was outstandingly different from all others. The first car to adopt it was the 1926 Packard. I am referring to the Hypoid gear.

(Writes)

Year	*Average*	*Gear tooth*
1924	1185	Loads per in. of
1930	1475	tooth face
1936	1720	
1937	1715	
1939	1720	

These are the average gear tooth per in. tooth face as determined by the company on the average cars most commonly sold. I have a year-to-year table, but am only taking excerpts from it. That increase comes about through the higher compression engines. About this time other manufacturers began using the Hypoid gear and now almost all are using it and there is not much change since 1936.

Pupil: Does that average mean it is the maximum tooth pressure you will obtain?

Leader: Yes, in high gear.

Pupil: Is that lb. per sq. in.?

Leader: No, per in. of tooth face and thus is only a rough index. The Hypoid gear and the conventional gear assembly look so much alike that most of us could hardly tell the difference if we examined the gear and pinion removed from one another; however, there is a difference in the shape and the fact is that in the conventional gear the tooth has a longer contact surface and in the case of the Hypoid gear, it slides a little. There is a slight sliding action, but normally this is considered to be a rolling action. The pinion slides on the tooth of the gear and the rubbing action causes a problem of gear lubrication. You can see that there might be need for stronger teeth, and the fact of the matter is that something was found to be needed because the failure is largely the result of fatigue on the teeth and by extensive tests it has been indicated that by the change of design the fatigue values in the Hypoid gear are five times as great as for the conventional gear. The strength of the latter is estimated to be about 50 percent greater than in the case of the Hypoid gear. There are various types of Hypoid lubes that have been developed to meet this situation. The first need is the passenger car and the passenger car as compared to heavy-duty operation. The passenger car will have a smaller running gear and it goes so much faster, perhaps 60 to 80 mi. per hr., whereas other vehicles will do mostly 30 to 40 mi. per hr. So by developing and finding out the difficulties and bringing them all down to date, it has been found that the sulphur type compounds have been superior in the case of the fast running passenger car. Then if you take this same lubricant and attempt to use it for heavy duty, it probably will fail and not only does it fail, but it fails rather miserably because it becomes an abrasive. At the last meeting we talked about the addition of sulphur to metal and that is what takes place here, combining sulphur with metal and getting metallic sulphide, which is a film and serves to separate even under extreme pressure. The test showed 400,000 lb. per sq. in. as being encountered from time to time. In the heavy-duty engine, if the sulphur has failed, they work with chlorine and chlorine type compounds bridge that gap. So with the passenger car, the characteristic would be high rubbing speed.

(Writes)

Passenger car	*Heavy duty*
High rubbing speed	High torque
	Heavier pressure

Pupil: One test was made using 2 percent sulphur at 20,000-lb. pressure and the coefficient of friction was only 0.077, and on the same oil using 10 percent lead oleate it was 0.11.

Leader: Ordinarily this soap is not so well thought of as lead naphthenate, is it?

Pupil: No.

Leader: There are about five different groups worth thinking about that are being used for these purposes:

(Writes)

1. Lead soap and sulphur.
2. Sulphur chloride.
3. Sulphurized fatty oils.
4. Chlorinated compounds.
5. Phosphorous compounds.

Some of these are going to be compromise products, and some of these compromise products have not been very good. I am not going to condemn any of them because I don't know which is which. Have any of you had any experience with phosphorous compounds? These five groups possibly cover most of the products. As early as 1937 the Chevrolet Motor Company had approved about 82 different compounds, commercial brands, so we are attempting to classify a large number in a small number of groups. Some day these will resolve into relatively few groups of extreme pressure lubricants. I think we are doing that now rather swiftly. Regarding temperatures that are encountered, the maximum temperature of the oil is approximately 400°F. in that film. General Motors, by using them in cars on the proving grounds, have found that temperatures of 80° to 100°F. above atmosphere result. So you can see that the lubricants are subjected to a very severe duty. General Motors also have found that under extremely high pressures the lubricant definitely hardens and becomes an abrasive. To give you some idea of a typical product:

(Writes)

Lead soap as oxide 1.5 percent
Sulphur 3.0 percent
Viscosity @ 210-95 Saybolt Universal

Pupil: What percent purity is that supposed to be?

Leader: 100 percent. These would have viscosities of about 95. The actual requirement is to not corrode the facilities. They may get dissolved, but if the film becomes firmly attached to the metal and serves as a coating against corrosion, it is successful.

Pupil: During some of our early work with extreme pressure lubricant a truck was used for the test and when they tore the rear end of it down, the only evidence of corrosion was on a bronze bushing and it was really bad.

Pupil: Just black, or pitted badly?

Leader: Quite often the bronze bushing will become black, but it will clean right off.

Pupil: It showed definite pock marks.

Leader: We have asked two people to give us some discussions of the grease situation tonight. One is going to talk on the manufacturing end of it and the other on the chemical end. Let us have the chemical part first.

Pupil: In handling this subject, I thought perhaps it might be better to go into the thing rather generally and I believe it would be well first to give a short history of grease. It has been brought out earlier in this class work that an examination of lubricants from axles of ancient Roman chariot wheels revealed the presence of fatty material and also some metallic substances, enough that it was stated it was indicated that soap was used. That was probably the first evidence we had of lubrication with grease. As far as grease as a lubricant is concerned, it dates back about as far as the development of petroleum. Earlier than that there were many mechanical mixtures and maybe some soap-thickened oils, but they were all fatty oils and no mineral oils. The first reference to a mixture of soap and mineral oil was about 1845, about the time petroleum began to come into the picture. Right here I should stop and define what I am going to call grease. I would say it was a soap-thickened mineral oil. There are many compounds on the market called grease that do not have any soap in them, but are merely mechanized mixtures of solids or semi-solids with mineral oils. Some of the first lubricating greases prepared about 1773 were lead soap greases and that is rather odd inasmuch as you know that lead soaps do not have any appreciable thickening effect on mineral oils. The only application for lead soap greases we have today is in extreme pressure lubrication. The modern type of lubricating grease was first manufactured about 1875; the actual mixture of hot or cold soap with oil. They had a sett grease before that time. One of the things that followed grease up to quite recent years was that grease-making was quite an art. When the greasemaker went to a place, he took his own formulas with him and told nobody what they were and when he left he took the formulas with him, and there was not much in the way of a control test—he just made it like he wanted it and trusted to his own judgment. I don't mean to say that recently we have gotten away from art in grease-making; there is still a lot of art to grease-making, but we are approaching the point where it is almost entirely a chemical engineering problem. There is still a lot of art to making emulsion of colloidal substances; however, as you know, the modern trend in machinery is toward lubricating more mechanical parts by oils and less by grease; consequently, you would think that the consumption of grease would decline, but it has not. There is so much more mechanized equipment that there is more demand for grease than there was several years ago; however, it is more of a specialized nature and isn't a cure-all for lubrication. You have to manufacture grease for a particular service. I believe I can state that all the larger manufacturers of lubricating greases, such as the larger oil companies, are doing research work in an effort to improve the products they have in order to meet competition. One of the big improvements in the last few years is the use of better lubricating oils. Only such greases as axle greases, which are sett products, and cup greases use cheap grade oil, and by cheap I mean either a poor grade or non-viscous oil. Before going into the theory of colloidal structure greases, I think it might be well to list the classifications of greases. I am not going to list these in the order of their importance, because I don't know that. To us probably the mixed soap would be the most important, but most discussions take up calcium soaps first, and then, of course, sodium soaps and mixed sodium calcium.

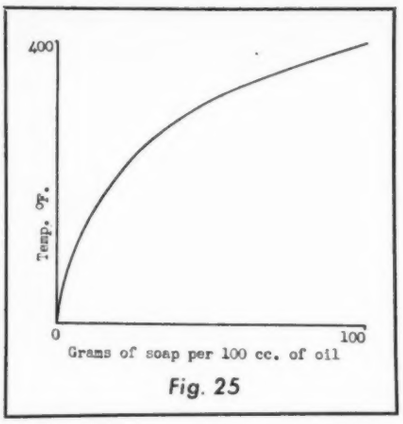


Fig. 25

(Writes)

1. Calcium soaps.
2. Sodium soaps.
3. Mixed sodium-calcium.
4. Aluminum soaps.
5. Lead soaps.

The fifth classification does not come directly in this discussion. Lead soaps and zinc soaps, etc., do not have much importance commercially. I believe there is some zinc soap used; by these soaps I mean soaps using mineral oil in preparing the grease. Regarding the colloidal structure of greases there are many theories and not many actual facts. There are theories regarding what the actual colloidal structure of the grease is. One thing we know, in order to have a colloidal or emulsion structure, we must have two phases, solid and liquid, and in most cases we have a third phase, which is water. Your solid is a soap and your liquid is mineral oil and water that may have various effects on the emulsion, depending on the type of soap and the amount of water, etc. Regarding solubility, we might draw a curve here on the solubility of the soap in oil. (Fig. 25.) Nearly all soaps are soluble to some extent in oil and we will say here is 400°F. and we will say that this is grams in 100 cc. of oil. This is merely diagrammatical. We begin at this point and probably don't have any solubility and then the curve starts upward, and then flattens out. This isn't an actual case, but is just about what takes place.

(This series will be continued in an early issue of *The Petroleum Engineer.*)

☆ ☆ ☆

Use of Entropy in Practical Diesel Engine Applications

PETROLEUM ENGINEER Exclusive Feature

☆ **Working knowledge of entropy important to an understanding of the internal-combustion engine, and to applying the fundamentals of thermodynamics in practice**

by Orville Adams

A WORKING knowledge of entropy is an important aid in understanding the internal-combustion engine, its development, and improvement. The concept of entropy is indispensable as an idea in the study and application of the fundamentals of thermodynamics. Carnot originated the concept of entropy in the development of his cycle. The Carnot cycle is a theoretical cycle, known as a perfect cycle for producing work from heat while operating between fixed temperatures. It is the cycle by which all other cycles are judged, and the one that Dr. Diesel intended to achieve in practice when he developed the engine known as the Diesel.

Entropy may be specifically defined as a concept, or an idea. Fundamentally, it is only a mathematical ratio. It is not measured like pressure, volume, and temperature. Entropy is *the ratio of heat change divided by the absolute temperature.* It is sometimes referred to as the distribution factor of heat, whereas the temperature is the intensity factor. As in physics, force is the intensity factor, distance is the distribution factor, and work is the product. Entropy has no basic unit, however, and only the change in entropy is significant. Changes in entropy are measured in what are known as "units of entropy," and there is no other name applied to such changes.

In the study of entropy, diagrams are given both on the PV (pressure-volume) and TS (temperature-entropy) axes. These make it easy to establish in our mind a mental picture of each process on both axes. For example: It is assumed that 1 lb. of air is heated at constant pressure from 60 to 61°F. As entropy is computed on the absolute scale, these figures become 519.6 and 520.6°F. abs. (459.6 + 60 = 519.6, etc.) Air has a specific heat of 0.240, and the heat added during one degree temperature change may be found from the expression:

ORVILLE ADAMS

was recently commissioned a lieutenant (s.g.) in the U. S. Naval Reserve, relinquishing his position as an engineer with the Guiberson Diesel Engine Company, Dallas, Texas, to enter the armed forces—He was educated at Kentucky State College and served in the technical branch of the army during the first World War —After his discharge from service he was for ten years sales engineer for Diesel engine manufacturers—Followed a period when he devoted his time largely to the writing of textbooks and articles for technical journals on the subject of the Diesel engine.

$$H = WC_p(T_2 - T_1)$$
$$= 1 \times 0.24(520.6 - 519.6)$$
$$= 0.24 \text{ B.t.u.} \quad \text{equation (1)}$$

where:

H = change in heat content (B.t.u.),
W = weight of gas,
C = specific heat of gas at constant pressure,
T_1 = initial temperature (abs.),
T_2 = final temperature (abs.)

And, as the entropy change is by definition:

$$\frac{H}{T} \text{ or } dS_1 = \frac{0.24}{520} = 0.0004615 \text{ entropy units.}$$

The value of 520 represents approximately the average temperature during the change. Again, suppose the same process is repeated for 1 lb. of air between the temperatures of 190°F. and 191°F. (649.6 and 650.6°F. abs.), the entropy change is approximately:

$$dS_2 = \frac{0.24}{650} = 0.000369 \text{ units of entropy}$$

where:

dS = increment in entropy.

Again repeat the process for 330 and 331°F., which is 789.6 to 790.6°F. abs., or an average of 790°F. abs. Then the change in entropy corresponding would be:

$$dS_3 = \frac{0.24}{790} = 0.000304 \text{ entropy units.}$$

Note that the letter d denotes an increment change, and S entropy, so dS denotes a minute change in entropy. Note also how the entropy decreases for each heat unit as the temperature decreases. On the T-S axes or plane, the areas shown represent heat change. This is to be expected. From a study of Fig. 1 it can be seen that as each unit of heat is added the temperature will increase uniformly and that the areas representing heat must increase uniformly. If, however, each heat increment (temperature) increases one dimension and the area remains the same, then the width or distribution must continue to decrease. This is a continuous smooth curve, and can only be defined by the usual equation from the calculus:

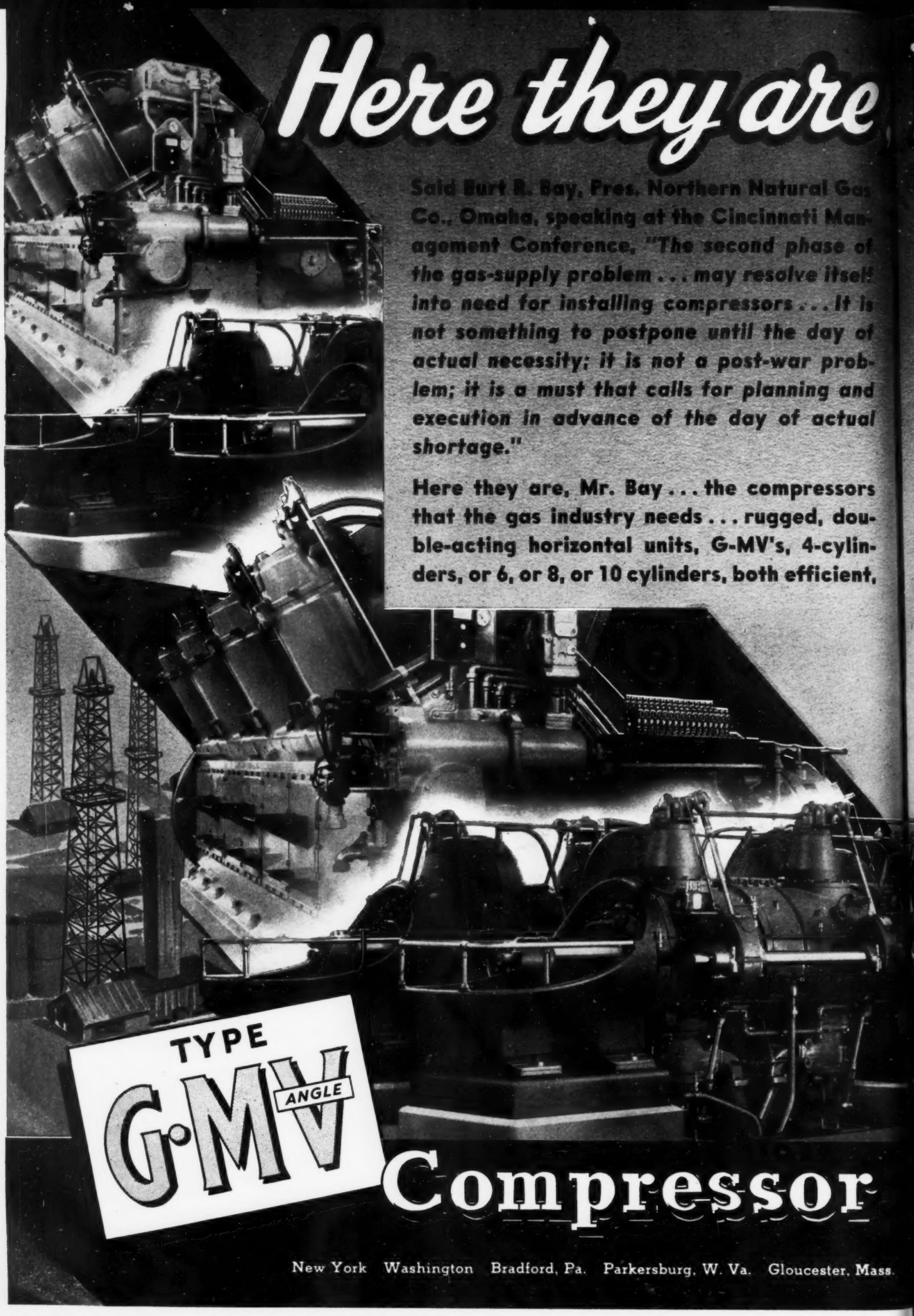
$$H = \int_{S_1}^{S_2} T\,dS \quad \text{equation (2)}$$

Expressing the equation in the differential form:

$$H = WC \int_{T_2}^{T_1} dT \quad \text{equation (3)}$$

These equations may be accepted without derivation and will not be equated for values here. Natural logarithms are used in the equations usually employed. These are logarithms to the base e= 2.781828, instead of the common logarithms to the base 10. They are converted from base 10 to base e by multiplying the base 10 logarithms by

(Continued on Page 46)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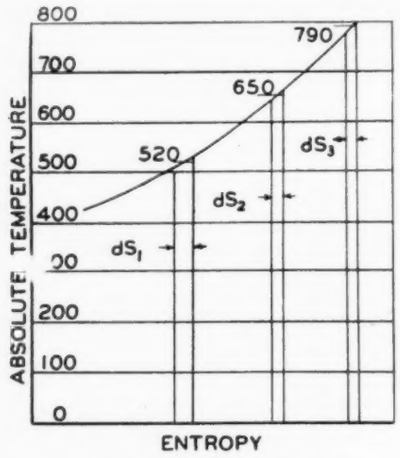


Fig. 1. Illustrating the principle of entropy

(Continued from Page 43)

2.3026. For example: Find the increase in entropy of 3 lb. of air heated at constant pressure from 40°F. to 270°F., C_p for air = 0.240

Solution: 40°F. = 500°F. abs., and 270°F. = 730°F. abs.

$$ {}_1S_2 = WC \log_e \frac{T_2}{T_1} $$

$$ \frac{T_2}{T_1} = \frac{730}{500} = 1.46 $$

$$ \log_e = 1.46 = 0.3784 $$

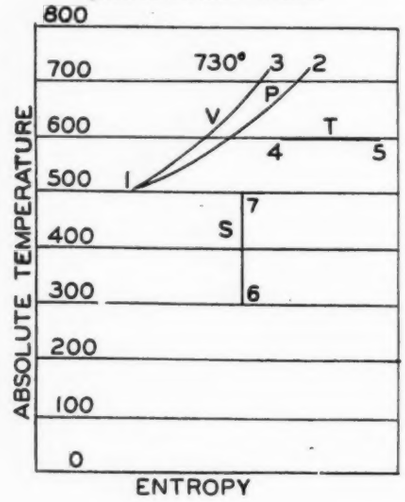
$$ {}_1S_2 = 3 \times 0.24\ (0.3784) $$

$$ = 0.27245 \text{ units.} $$

These are "entropy units" and represent only a change in entropy from point 1 to point 2, as there are no absolute units for either point. (See Fig. 2.)

Example: Find the increase in entropy for the same conditions as the above example, but assume the heat is added at constant volume instead of constant pressure. C_v for air is 0.171.

Fig. 2. Temperature-pressure-volume plotted on the T-S axes



Solution: ${}_1S_3 = s \times 0.171 \times 0.3784$

$$ = 0.19412 \text{ units.} $$

Example: Let 5 lb. of carbon dioxide (CO_2) expand isothermally at a temperature of 140°F. from a volume of 6 cu. ft. to a volume of 18 cu. ft. (a) How much work is done during the process, (b) How much heat is added, and (c) What is the change in entropy during the process?

Solution: 140°F. = 140 + 460

$$ = 600°\text{F. abs.} $$

(a) Work = $wRT \log_e r$

r = expansion ratio

$$ r = \frac{18}{6} = 3 $$

$$ \log_e 3 = 1.0986 $$

Work = $5 \times 35 \times 600\ (1.0986)$

$$ = 115{,}353 \text{ ft-lb.} $$

(b) Heat added = $\frac{W}{778} = \frac{115{,}353}{778}$

$$ = 148.27 \text{ B.t.u.} $$

(c) Entropy change = $\frac{{}_4H_5}{T}$

$$ = \frac{148.27}{600} = 0.27412 \text{ units of entropy.} $$

Each of these examples shown above are plotted on the T-S axes in Fig. 2, and the process is indicated as designed by symbols as follows:

P = constant pressure, line 1-2,
V = constant volume, line 1-3,
T = constant temperature, line 4-5, and
S = entropy, also constant, line 6-7, for which no example is given.

This is the adiabatic process, and it is important to observe that the compression and expansion lines on both the Otto and the Diesel cycles are theoretically adiabatics.

Comparison of Processes

Fig. 3 shows the four key processes on the PV and TS planes or axes. These are as follows:

Process	*Line*	*Constant element*	*Symbol*
Constant pressure	A-1	Pressure	P
Isothermal	A-2	Temperature	T
Adiabatic	A-3	Entropy	S
Constant volume	A-4	Volume	V

It is no simple matter to recognize the paths of these processes on the respective planes. Only a continued use and study of them makes it possible to identify the various processes in a general way. In the solution of problems it has been found advantageous to sketch all gas processes on both planes, not necessarily to scale.

Otto Cycle on PV and TS Axes

The Otto Cycle consists of two adiabatics and two constant volume processes. These well-known diagrams are shown in Fig. 4. The notation of points and lines are the same for both axes. The line A-B is an adiabatic (constant entropy) compression. During this process the temperature increases due to work done by the piston on the gas, but no heat is added to the gas. Line B-C is

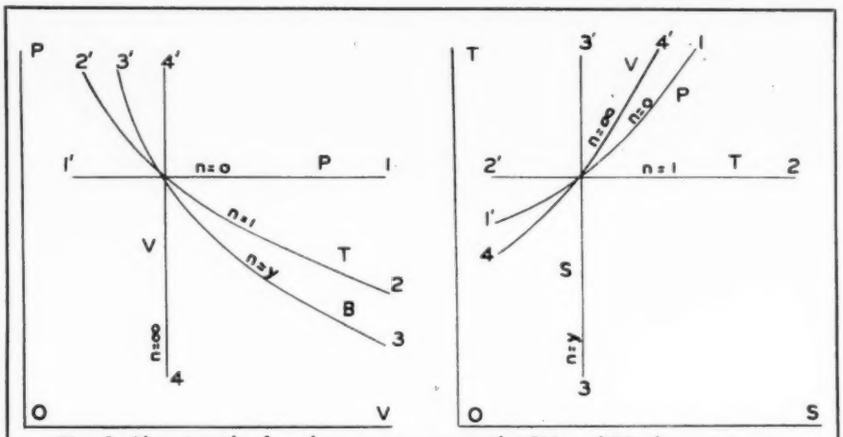


Fig. 3. Showing the four key processes on the PV and TS planes or axes

a constant volume process during which the gas charge in the cylinder is burned, and heat is liberated resulting in a temperature increase. This is the constant volume process, and for the purpose of comparison, the constant pressure process is shown as a dotted line on the TS axes. C-D is the adiabatic expansion, which is also identified as the "working stroke" of the cycle. Here, the gas expands, converting its heat into work on the piston, and allowing the temperature of the gas (now burned) to decrease. Line D-A may be considered a constant volume reduction process, however, in actual practice the heat is rejected or exhausted. The exhaust and intake stroke have no place on the theorectical diagrams, as theorectically no work is done and no thermal process occurs.

On each diagram, the points define the instantaneous conditions, the lines define the process, and the areas repre-

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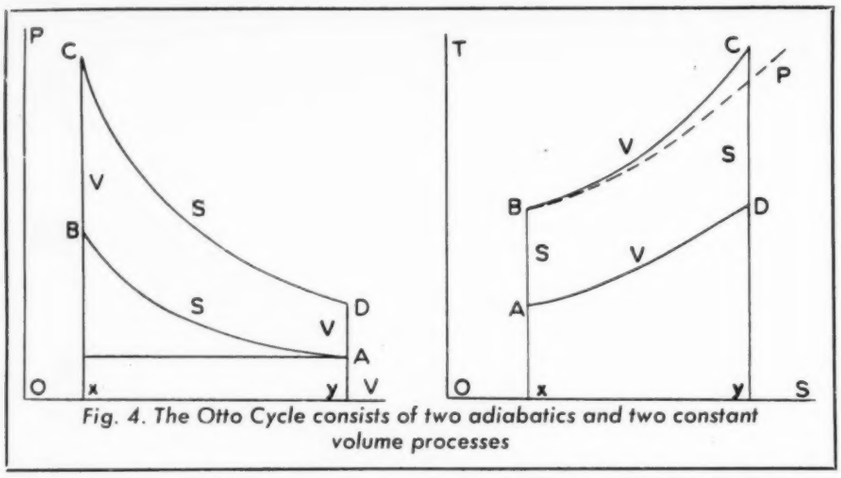

Fig. 4. The Otto Cycle consists of two adiabatics and two constant volume processes

sent work on the P-V plane and heat quantities on the T-S plane. On the P-V diagram (Fig. 4) the area under the line A-B, yABx, represents to some scale the work required to compress the charge in the cylinder. The line B-C indicates the pressure (temperature) rise of the charge due to combustion. The line C-D shows the expansion process or "work stroke" of the cycle. The area, C-D, being xCDy, is the total work done by the gas on the piston during the expansion. The area, ABCD is, therefore, the net work of the cycle.

On the T-S plane, the line A-B is vertical, indicating a temperature increase with no increase in entropy. This is an adiabatic compression. The line B-C indicates the heat added at constant volume during the combustion, and the heat is represented by the area xBCy. After a constant entropy, (adiabatic) expansion from C to D, the remaining heat is rejected. The rejected heat is shown by the area yDAx, and the net heat converted into work is indicated by the area ABCD. If the area ABCD on the P-V axis is scaled to give ft-lb., and is then divided by 778, it should equal the area ABCD on the TS axis, when scaled as B.t.u.

Diesel Cycle on PV and TS Axes

The Diesel Cycle is the same as the Otto Cycle on both planes or axes, except for the process during which combustion occurs. (See Fig. 5.) This process is designated by the line B-C on both axes, and is a constant pressure process. For comparison, a constant volume process beginning at point B is shown as a dotted line. Note that on the T-S plane, the length of the compression line A-B is greater than the expansion line C-D. This is to be expected, for the simple reason that the expansion and compression ratios are different for the two cycles.

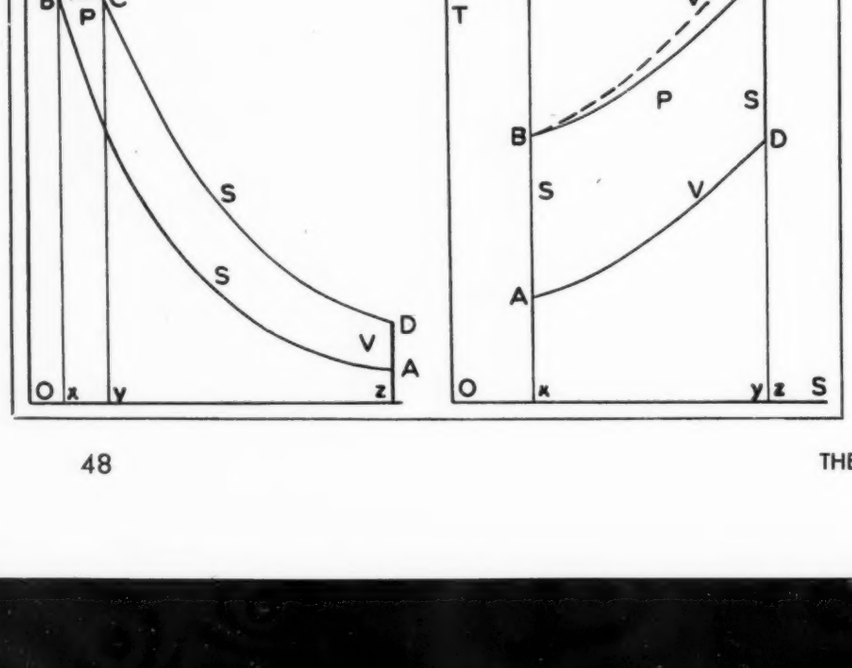

Fig. 5. The Diesel Cycle

Carnot Cycle

The Carnot Cycle is known as the perfect cycle. This means it is a theorectical and not a practical cycle, yet it is useful as a criterion, and requires a brief study.

As shown in Fig. 6, the Carnot Cycle consists of two isothermal and two adiabatic processes. Beginning with point A, the gas is compressed isothermally from A to B. This process involves the removal of heat equal to the area under the line A-B on the T-S diagram. The gas is then compressed adiabatically from B to C. There is no heat gain or loss during this process, and the entropy remains constant, but the temperature increases. Heat is then added during the expansion C-D at a rate sufficient to maintain a constant temperature. This is the second isothermal process, and the heat added is exactly equal to the work done. The heat added is represented graphically by the entire area under the line C-D on the TS axes, xCDy. This cycle is completed by the adiabatic expansion D-A, which returns the gas to its initial condition. The entire cycle is predicated upon the use of a piston and cylinder that are perfect non-conductors of heat. Within the cylinder, however, there must be a heating and a cooling element each of which functions at a fixed rate during a given part of the cycle.

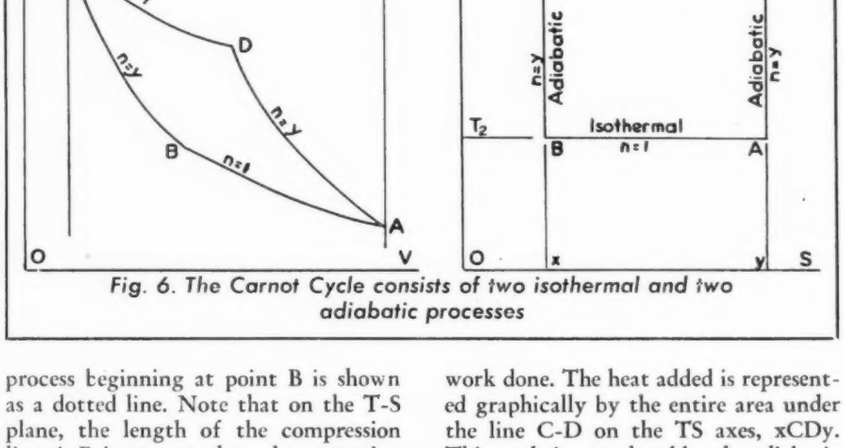

Fig. 6. The Carnot Cycle consists of two isothermal and two adiabatic processes

Such a cycle has an efficiency of $H_1 - H_2/H_1$, or as usually expressed, $T_1 - T_2/T_1$, for the heat areas are rectangular and all have the width x-y. The heat added, H_1, is shown by the area xCDy, or $T_1 \times Sy$, and the heat rejected, H_2, is shown by yABx, or $T_2 \times Sx$. This is the most efficient cycle that can operate between the temperature limits of a heat source T_1 and a cooling or exhaust temperature of T_2.

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P 420.111

Inspection and Analysis Of Formation Samples

Exclusive

☆ Orientation of cores; segregation and identification of mineral components and micro-fossils in formation samples

by Lester C. Uren

Professor of Petroleum Engineering, University of California

THE preceding articles of this series have dealt with lithologic properties of particular interest to the petroleum engineer in his studies of fluid content, storage capacity, and drainage of reservoir rocks. The geologist is also concerned with the characteristics of reservoir rocks, but in addition to the lithologic properties of formation samples, he is also interested in other indications that will be of assistance in estimating the dip and strike of strata and their identification and correlation from well to well. The present article will be concerned particularly with the methods of orienting core samples taken in the course of drilling and determining therefrom the inclination of strata; and techniques employed in segregating and classifying the mineral and fossil content of formation samples as an aid in correlation of strata and interpreting structural relationships.

Orientation of Cores

For many years, geologists and petroleum engineers have sought a dependable means of orienting cores taken in the course of well drilling, so that the stratification they display may be used to determine the dip and strike of formations penetrated. Such information is particularly helpful in determining the direction from the well in which the cores are taken, of crestal areas of structures encountered below unconformities or fault planes. In rotary drilling, primitive and costly methods of orienting the drill pipe and core barrel as they are withdrawn from the well has provided a possible solution for this problem, but these methods present inherent inaccuracies that cast considerable doubt on the usefulness of the data procured.

An important advance in the technique of core orientation was made with the development of a method that involves determination of the magnetic polarity of the core. The procedure, which is carried out in the laboratory with the aid of special equipment, is designed to determine the original orientation of the core as it existed in place in the earth, by observations on the residual magnetic polarity in the heavy minerals present.

LESTER C. UREN

It has been found that many mineral crystals in igneous and plutonic rocks possess slight permanent magnetism, induced in them by the earth's magnetic field as the rocks cooled from the molten state. In later geologic history, as the older rocks are weathered and eroded away, the crystals composing them are freed and deposited in sedimentary formations, and as some of these crystals possess a weak magnetic polarity, there is a tendency for them to be deposited with their poles in the magnetic meridian. Although many such crystals are deposited in other positions, there is usually a sufficient majority oriented in the meridian to confer a distinct polarity to samples containing them. In addition to this orientation during the process of sedimentation, the mineral crystals are weakly magnetized by long standing in one position in the earth's magnetic field. To determine the original orientation, it is only necessary to provide an instrument sensitive enough to locate the magnetic north and south poles of the core.

We must distinguish between the terms "polarity" and "magnetic susceptibility." "Polarity" is defined as that property of a mineral that enables it to acquire and retain magnetic polarity responsive to the earth's magnetic field. "Susceptibility" may be defined as that characteristic of a mineral that enables it to acquire magnetic properties which it does not retain after removal from the influences that have imposed a magnetic polarity. Many minerals are susceptible to magnetic forces but do not retain the polarity of the earth's field after they have been removed from it.

Minerals may be classified in accordance with their magnetic properties into four groups: (1) Highly magnetic minerals, such as magnetite and pyrrhotite; (2) moderately magnetic minerals, such as ilmenite, chromite, and glanconite; (3) weakly magnetic minerals such as monazite, staurolite, and tourmaline; and (4) practically nonmagnetic minerals, such as quartz, feldspar, zircon, spinel, etc. Unfortunately, some materials commonly present in core samples, such as limestone, dolomite, anhydrite, and diatomite, have no magnetic properties. Of course, formation cores usually consist of a variety of different minerals having different magnetic properties, and the success of the magnetic method of core orientation will depend upon the amount of magnetic material present.

In preparation for a magnetic polarity test, the core must be shaped by machine methods and it should therefore be of well indurated material that will not disintegrate readily. The sides of the core are dressed to as nearly true cylindrical form as possible and the ends cut to smooth circular planes at right angles to the cylindrical axis. The upper end of the core is marked for identification and well defined bedding planes that may be apparent in the core are marked clearly on the cylindrical

Parts Play Important Part
Whirling blades in the sky depend upon accurately machined Ferrules and other Special Parts—parts which play a vital role in propeller performance. These, along with numerous other items for war, are being mass-produced by Hughes Tool Company.
And equally important is the production of Oil Well Drilling Tools which help produce Oil to "Keep 'em Flying."
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surface to assist in later goniometric measurements.

An apparatus[1] suitable for use in determining the magnetic polarity of core samples, has been developed and patented by members of the staff of the Standard Oil Company of California, and the Sperry-Sun Well Surveying Corporation has been licensed to use this apparatus in commercial testing. The apparatus provides a means of supporting and slowly rotating the prepared core in a horizontal position. Two magnets in astatic balance are supported near the core in a duralumin damping case, on a strand of copper-beryllium wire, so that they are free to turn in a vertical plane. (See Fig. 1.) The entire instrument is shielded from the earth's magnetic field by a cylindrical housing of soft steel. A small mirror, attached to the frame that supports the magnets and turning with it, reflects a beam of light from an external source, so that it falls on a sheet of sensitized photographic paper mounted on the surface of a drum that rotates in synchronism with the core.[2]

As the core slowly revolves, the north end of the lowermost of the two magnets is attracted to the south pole of the core and vice versa. A line is drawn on the cylindrical surface of the core, parallel with its longitudinal axis, indicating the side of the core that displays maximum attraction for the north pole of the lowermost magnet, and this is marked as the south pole of the specimen. It should be reproducible in repeated tests within a few degrees of arc. This is the side of the core that was toward the magnetic south as it existed in the earth. Suitable goniometric observations designed to measure the angle between a plane through the north and south poles of the specimen and the bedding planes, will determine the amount and direction of dip of the strata. A horizontal line at right angles to the dip angle, in the direction of the bedding planes, indicates the "strike" of the beds.

Rather than place dependence on tests with a single specimen, it is preferable to base computations on the average of tests made on several cores taken a few feet apart. The average result is conveniently indicated on a circular chart on which the direction of strike and dip are shown with respect to the points of the compass, whereas the amount of dip is indicated by reference to a series of concentric circles, each of which represents a certain degree of dip from the horizontal. (See Fig. 2.) When a core is taken in a well that is not vertical, suitable corrections must be applied to the apparent dip and strike to obtain the true values. An apparatus called a "deviation corrector" has been devised for mechanically solving such problems.

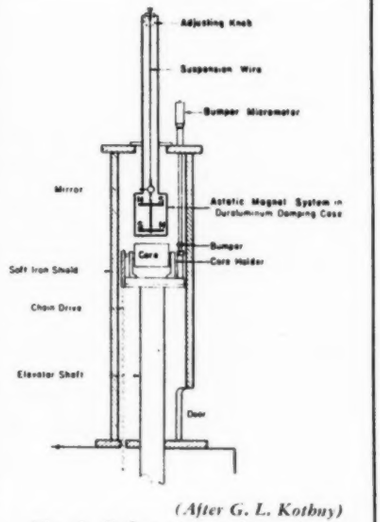
[1]"Orientation of Cores," G. A. Macready, *A.A.P.G. Bull.*, May, 1930 (Vol. 14, No. 5), pp. 559-578.

[2]"Magnetic Method of Orienting Cores," G. L. Kothny, *The Petroleum Engineer*, April, 1927, p. 116.

Formation Sample Constituents

The color of a formation sample is often an index of the nature of the prevailing mineral constituent. Thus, a pure white crystalline sand of vitreous luster is generally composed largely of quartz, whereas other light colored sands often contain large percentages of the feldspars or granular limestone or dolomite. Reddish or yellowish sands will usually be found to be stained with a secondary coating of iron oxide. Green sands often contain important amounts of epidote, olivine, and other secondary minerals derived from the less persistent primary silicates. The color of a sample will usually be more pronounced when it is wet.

Sand grains are often coated with secondary minerals that tend to mask



(After G. L. Kothny)

Fig. 1. Polar core orientation instrument

their true color, transparency, and crystalline form. Boiling in a dilute solution of hydrochloric acid (commercial HCl diluted with an equal amount of water) will remove much of this surface material, leaving the siliceous mineral grains in a condition that facilitates their subsequent identification by petrographic inspection under the microscope.

Familiarity with the color, crystalline form, texture, and cleavage of the common rock-forming minerals will enable the observer to identify quickly the mineral grains under a binocular microscope. Absolute identification of the various minerals may be made only by more tedious methods designed to determine the refractive index, birefringence, crystallographic form, color, pleochroism, interference figure, and other properties with the aid of a petrographic microscope.

Still other techniques, as yet not fully developed or applied in the inspection of formation samples, involve not only identification of the minerals present, but studies of the shape of grains, character of grain surfaces, and nature of secondary cementing materials that disclose the life history of the specimen and the character of sedimentation that was responsible for its formation.

Mineral Components

A large percentage of the mineral components of most formation samples consists of ordinary rock-forming minerals of low or medium density. In many samples, however, there will also be present smaller amounts of less common minerals of high density and their presence may be a peculiar characteristic of the strata from which they come. Such minerals as chromite, chlorite, muscovite, biotite, zircon, garnet, tourmaline, rutile, titanite, glaucophane, epidote, hornblende, angite, actinolite, barite, anhydrite, etc., are seldom predominant minerals in a formation sample, and in the aggregate may represent but a small percent of the total mass of the sample. Yet, one or another of these minerals may be present in abnormal amounts, or the assemblage of these less common minerals may present certain characteristic ratios. If this is found to be the case, such an occurrence will often be a valuable index for correlation of formations within areas of limited expanse, and to differentiate an individual stratum in the section from those above or below it.

Because of the small amounts of such minerals commonly present, they are obscured and their identification made difficult by the presence of much larger amounts of the lower density minerals. Any process of concentration that will segregate some of the mineral components, particularly the minerals of higher density, will therefore facilitate their identification. Methods of concentrating various components include the following techniques:

1. Heavy mineral concentration by gravitational segregation with the aid of heavy liquids,

2. Magnetic separation of minerals possessing magnetic susceptibility,

3. Dielectric separation of minerals, and

4. Electrostatic separation of minerals.

Heavy mineral concentration by gravitational segregation with the aid of heavy liquids. A convenient

method of separating the lighter from the heavier mineral grains in a disaggregated sand or sandstone formation sample involves floating the lighter mineral-grain components on a heavy liquid through which the heavier grains will sink. Either of several different heavy liquids may be used for this purpose, among which are bromoform, acetylene tetra-bromide, stannic bromide, antimony tribromide, thallium formate, and mixtures of mercuric chloride and mercuric iodide.[3] Of these "bromoform" ($C H Br_3$) (density 2.89) and acetylene tetra-bromide (density 2.96) are most useful. By dilution with benzene or carbon tetrachloride, liquids of lower density may be prepared with these reagents, if desired.

Bromoform is less expensive than other heavy liquids and is generally preferred for heavy mineral segregation. It is commercially available, chemically inert, non-poisonous, and can be recovered and purified from filtered residues for further use. Separation of the light and heavy mineral "crops" is conveniently effected in a separatory funnel or porcelain evaporating dish, stirring the mixture of disaggregated mineral fragments and bromoform to facilitate segregation. If a separatory funnel is used, the heavy "crop" that has settled in the bottom of the funnel is drained away into an ordinary funnel and caught on filter paper through which the residual bromoform is washed with alcohol. The heavy "crop," often representing less than 1 percent of the total mass of the formation sample, is then dried and is ready for microscopic inspection.

Identification of the various minerals present in the heavy mineral aggregate may be effected by one skilled in petrographic methods, either by sight inspection under the binocular microscope or by analytical procedures with the petrographic microscope. A count is made at random of, say, 100 mineral grains, and the percentage of each mineral is recorded. Interest may center on abnormal amounts of a particular mineral or on the variety and percentages of different minerals in the assemblage.

Separation of heavy minerals possessing magnetic susceptibility. Minerals vary in susceptibility to magnetic influences as explained in an earlier section. Some, like magnetic pyrrhotite and certain varieties of ilmenite and hematite, are attracted by a weak magnetic field. Others, like chromite, garnet, glauconite, tourmaline, siderite, epidote, olivine, monozite, and some varieties of ilmenite, hematite and amphiboles and pyroxenes, are weakly susceptible and respond only to the influence of a strong magnetic field. Still others, among them common rock-forming minerals such as quartz, feldspars, calcite, etc., are not influenced, even by a powerful magnetic field.[4]

In response to magnetic influence, mineral grains may readily be segregated from others less so by bringing them into contact with or proximity to a horse-shoe magnet, or the poles of an electro-magnet. Only highly magnetic minerals will cling to a permanent magnet, but an electro-magnet may be made powerful enough to attract and hold minerals of lower magnetic susceptibility; and by varying the strength of the magnetic field, components of different magnetic susceptibility may be segregated. Mineral grains so separated from a sand or disaggregated sandstone formation sample may provide a basis for identifying the stratum from which they come.

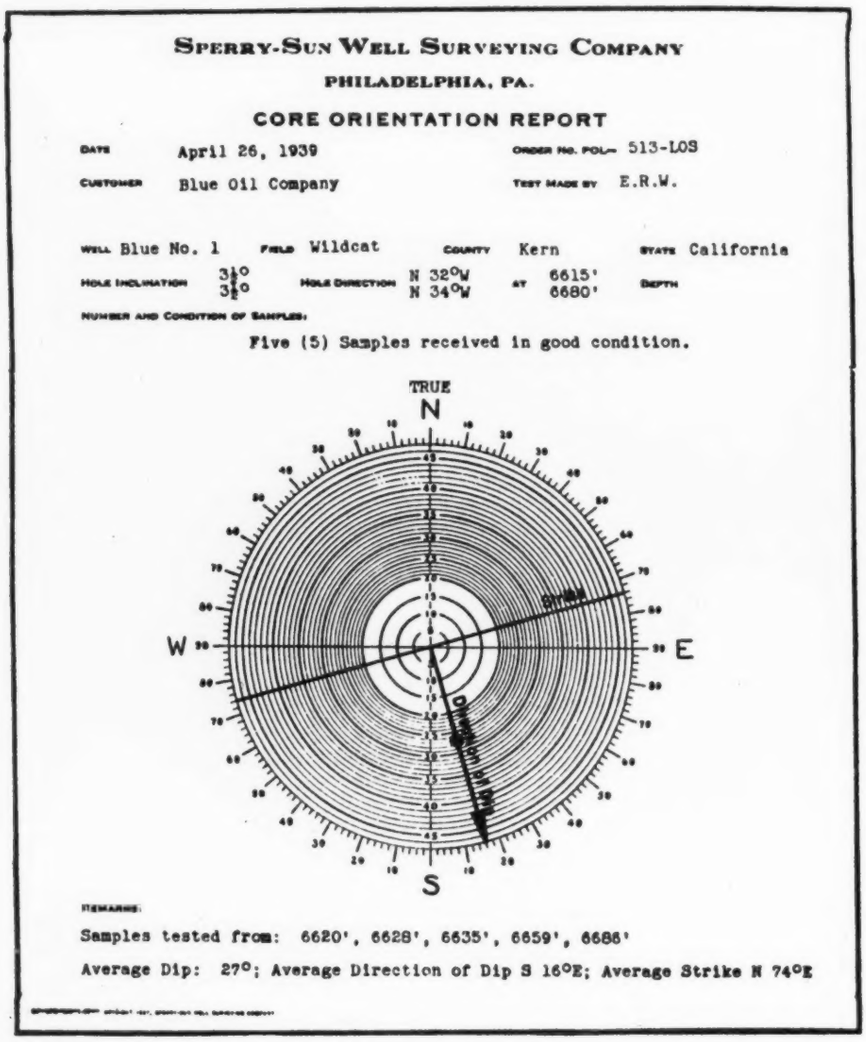
Dielectric separation of mineral grains. Minerals display resistance to passage of electrical discharge through them in varying degree. This property may provide a basis for concentration of certain mineral grains in disaggregated formation samples. The mineral grains are immersed in a liquid such as nitrobenzene, of known dielectric strength, and a voltage of from 300 to 400 volts imposed by immersing two closely-spaced electrodes in the liquid. Mineral grains having a dielectric constant greater than that of the liquid will be attracted to a position between the electrodes and may be removed for examination and mineralogic classification. Such minerals may be found to be a peculiar characteristic of the stratum from which they come.

Electro-static separation of mineral grains. Still another method of segregating certain minerals that may have diagnostic value in study of for-

[3] "Heavy Liquids for Mineralogical Analysis," J. D. Sullivan, U. S. Bureau of Mines Tech. Paper 381 (1927).

[4] *The Examination of Fragmental Rocks*, F. G. Tickell, Stanford University Press, 1939.

Fig. 2. Illustrating method of graphically displaying core-orientation data
(After G. L. Kothny)



SPERRY-SUN WELL SURVEYING COMPANY

PHILADELPHIA, PA.

CORE ORIENTATION REPORT

DATE April 26, 1939 ORDER NO. POL— 513-LOS

CUSTOMER Blue Oil Company TEST MADE BY E.R.W.

WELL Blue No. 1 FIELD Wildcat COUNTY Kern STATE California

HOLE INCLINATION 3½° 3½° HOLE DIRECTION N 32°W N 34°W AT 6615' 6680' DEPTH

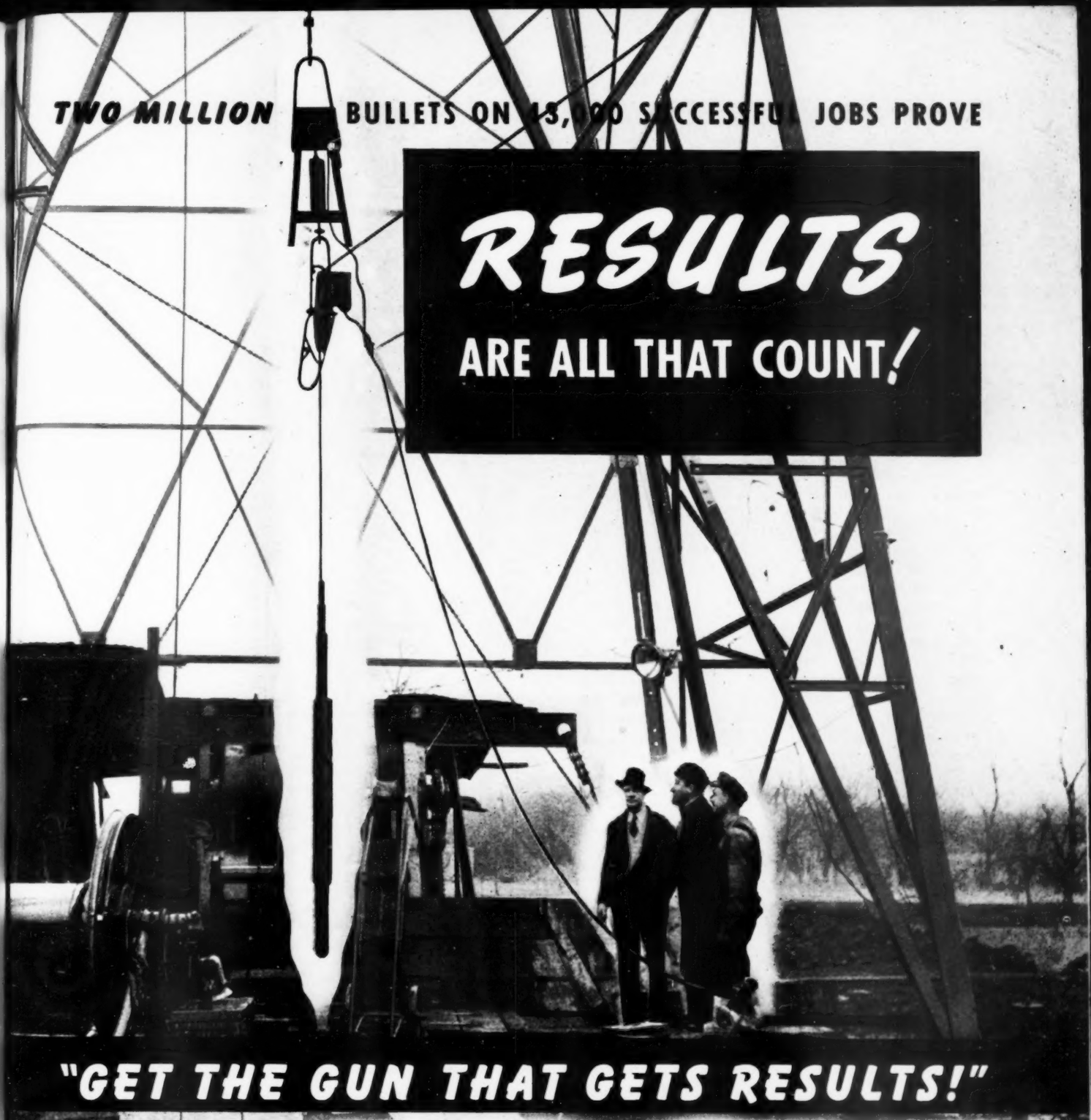
NUMBER AND CONDITION OF SAMPLES:

Five (5) Samples received in good condition.

REMARKS:

Samples tested from: 6620', 6628', 6635', 6659', 6686'

Average Dip: 27°; Average Direction of Dip S 16°E; Average Strike N 74°E



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mation samples involves bringing them into the field of influence of an ebonite rod that has been charged with static electricity by rubbing it with fur or flannel. Disaggregated mineral grains to be tested by this method are placed in an electrically grounded copper pan and the charged rod brought in close proximity to them. Mineral grains that are non-conductive are positively charged and will attach themselves to the negatively charged ebonite rod, whereas others that are electrically conductive will be uninfluenced.

Identification of commonly-present carbonate minerals in calcareous formation samples. Different carbonate minerals are soluble in acids in varying degree, and this may provide a convenient basis for distinguishing between component members of a limestone formation. Thus, calcite is freely soluble in cold dilute hydrochloric acid, whereas dolomite and magnesite are less soluble. Magnesite is of higher density than dolomite and gravitational segregation provides a convenient means of distinguishing between them. This technique is useful in estimating the ratios of these minerals in calcareous samples, which may have stratigraphic significance. Thus, the ratio of calcite to dolomite often shows diminishing values below an unconformity that might be difficult to recognize by other means.

In making segregations of carbonate minerals, the sample is first ground to pass an 80-mesh screen and about 2 cc. is placed in a 15-cc. graduated centrifuge tube with about 10 cc. of a solution of mercury iodide and potassium iodide (density 2.75). The material in the tube is shaken and centrifuged and such portion of the sample as remains afloat is poured off. This light "crop" is then re-centrifuged in water and the volume of mineral noted by reference to the graduations of the centrifuge tube. Dilute hydrochloric acid is added and the observed loss of volume of the mineral by solution in the acid is taken as the calcite content. Material that sank in the 2.75-density iodide solution is re-centrifuged in an iodide solution of 3.05-density. The floating "crop" is poured off and re-centrifuged in water, the volume noted, and after treatment with concentrated hydrochloric acid to which a little nitric acid has been added, the loss in volume of the mineral by solution is considered to be dolomite. To the heavy "crop" concentrated in the bottom of the centrifuge tube in the 3.05-density solution, water is added and the mineral again concentrated in the bottom of the tube by further centrifuging. The volume is noted, concentrated hydrochloric acid and a little nitric acid are added, and the loss in volume of the mineral by solution is regarded as the magnesite component. If anhydrite is present it will be dissolved partially in the acid treatment of the medium-density fraction. In this case, the sulphate content of the solution must be analytically determined, the equivalent volume of anhydrite computed and subtracted from the total volume loss to determine the volume of dolomite present.[5]

Concentration and examination of insoluble residues in calcareous formation samples. Limestone formations are important reference horizons and reservoir rocks in many petroliferous regions. Often it is important to be able to recognize particular "markers" in such formations, in tracing particular beds from well to well in a given field, or in making long-distance correlations between different localities. A useful technique, applicable only to calcareous formation samples, is one in which the carbonate minerals are dissolved in acid, leaving insoluble residues that, under the microscope, may often be recognized as characteristic of the horizons from which they come. The residues that are left unchanged by the acid treatment are usually foraminifera, silicified fossils, grains of quartz, feldspars, or other minerals of siliceous character.

A convenient method for dissolving calcareous material and concentrating the insoluble residue involves digestion of a pulverized sample in dilute hydrochloric acid prepared by diluting concentrated commercial HCl with an equal volume of water. One authority treats approximately 12 gm. of the sample with 5 to 10 cc. of the dilute acid, until the active effervescence ceases, then adds 75 cc. more of the acid and allows it to stand until all effervescence ceases. Clay, inorganic precipitates, and other fine material tending to remain afloat in the acid are decanted off and additional acid is applied until complete solution of all soluble material is assured. After complete digestion, the insoluble residue is washed several times on filter paper to eliminate all acid, soluble salts and finer particles and the coarser residues are dried and inspected under the binocular microscope to determine their character. A preponderance of one particular type of residue, or the presence of some unusual mineral or micro-fossil, may be found to be characteristic of the stratigraphic horizon from which it comes.[6]

Micro-Fossils

A field of scientific study that has found wide application in geologic correlation in connection with petroleum exploration and oil-field development, involves microscopic identification of the micro-fossils that are frequently found in formation samples of sedimentary origin. Foraminifera and diatoms are abundant in rocks formed during certain periods of the earth's history, particularly in rocks of Cretaceous, Oligocene, Eocene, and Miocene periods. Marked variations in the skeleton forms of these micro-organisms are noted, and often it will be found that a certain variety of micro-fossil is characteristic of a narrow formational interval over a wide area. Thus, the presence of a certain species may serve to identify a particular stratum wherever it is encountered within a given region or province. Foraminifera have been most used in this type of work, though some workers have made effective use of diatoms.

Formation samples to be subjected to micro-palaeontological inspection are disaggregated, the finer material is washed through sieves or decanted, and the residue of sandy, coarser material that contains the micro-fossils may then be subjected to gravitational classification, dried and hand sorted under the binocular microscope to find representative fossil specimens. Preliminary study will have established a series of reference specimens considered to be characteristic of different stratigraphic horizons, and these are permanently mounted on microscopic slides for comparative purposes.

Twenty years of research have established reference species for most of the important oil-producing regions of the United States, and identification of micro-fossils is now a widely used method of geologic correlation. Most of the major oil companies support core-inspection laboratories equipped for this work, with skilled personnel in charge. Micro-palaeontological studies are depended upon for most of the geologic correlation work in some regions, and all cores taken in the course of drilling are regularly inspected to identify the species of micro-fossils that may be present.

Micro-palaeontology and petrography are sciences with which the petroleum engineer is expected to have only passing acquaintance. Study of formation samples by these methods is ordinarily entrusted to geologists who specialize in these fields. An extensive literature relating to them has been built up in the last 20 years, which is inadequately reflected in the brief outline here presented, and the reader is referred to the bibliography printed in the May, 1943, issue of *The Petroleum Engineer* for more detailed information.

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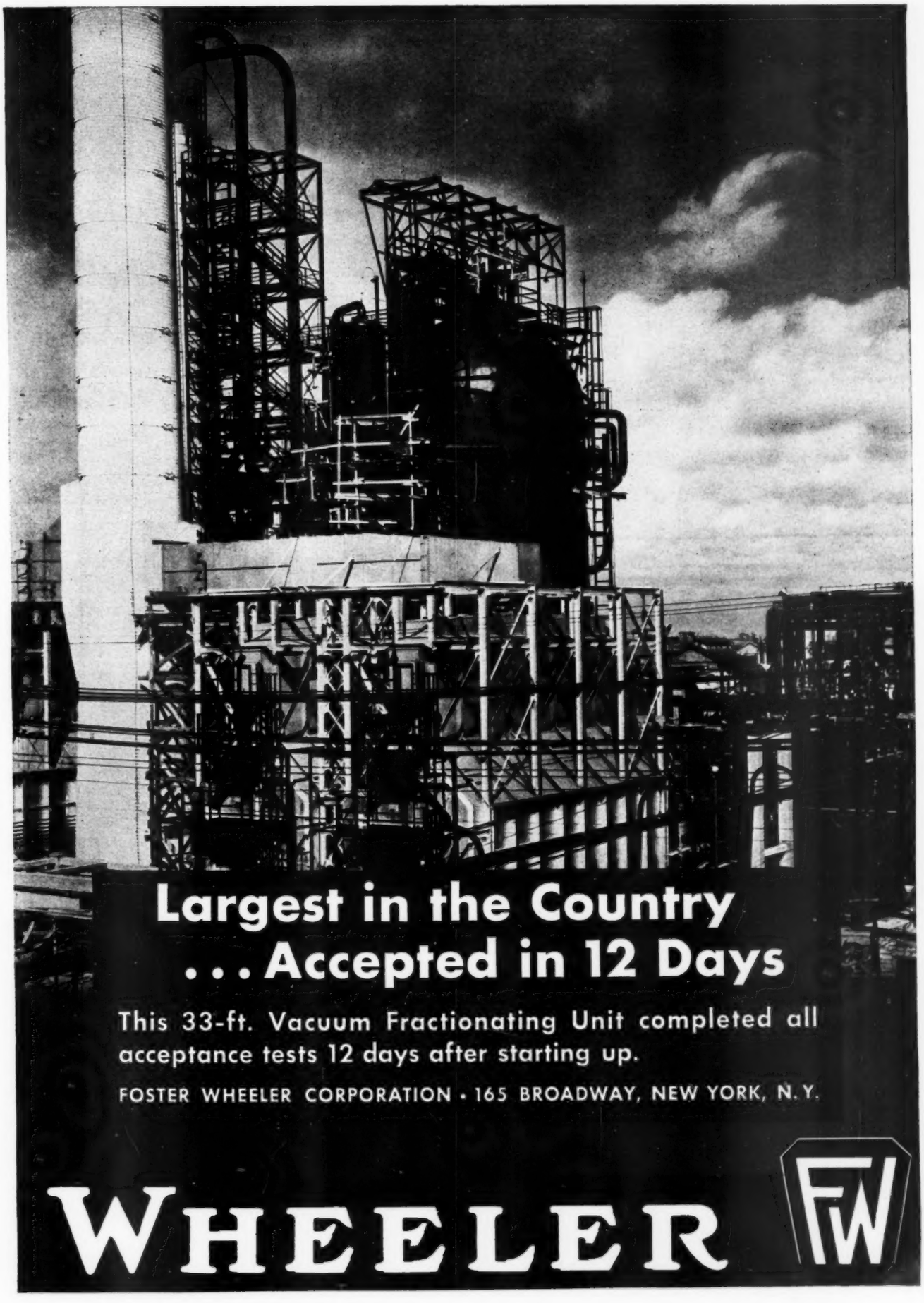
[5] "Method of Examining Calcareous Well Cuttings," C. B. Claypool and W. V. Howard, *A.A.P.G. Bull.*, December, 1928, pp. 1147-52 (Vol. 12, No. 12).

[6] "Use of Insoluble Residues for Correlation in Oklahoma," H. A. Ireland, *A.A.P.G. Bull.*, August, 1936, pp. 1086-1121 (Vol. 20, No. 8).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☆ **Installation design and selection of equipment should be based on adequacy and observation of war-time precautions**

by Davis H. Tuck, Electrical Engineer,
Holophane Company, Inc.

LIGHTING methods and equipment for the oil refining industry, may for the convenience of discussion, be divided into two general groups. The first group of locations requiring lighting are the actual production areas and the second group are the administrative and maintenance areas. The additional refinery capacity being built for the war requirements coupled with restrictions on critical materials makes lighting for the industry a timely subject. This article will treat only the Group 1 (production) areas.

This article, then, will discuss, blackout lighting, dimout lighting, the lighting of booster station, bubble towers, condensers, control room, evaporators, fences, loading racks, locker and change house, pipe stills, pump house, roadways, stripping towers, vaporizers, walk paths, and yard.

In general, all lighting equipment used in oil refinery work should be of substantial and rugged construction. The reflecting surfaces of the lighting unit should be of a permanent nature and not subject to permanent depreciation due to fumes, salt air, heat, cold and weather.

In making lighting calculations a depreciation factor must be included to compensate for temporary dust and dirt depreciation and lamp aging. The factors used will depend on the type of lighting used and the values in Table 1 represent good practice.

TABLE 1

Incandescent or combination incandescent-mercury equipment		
Lamp depreciation	0.85	0.068
Dust and dirt	0.80	
Mercury equipment		
Lamp depreciation	0.85	0.60
Dust and dirt	0.70	
Fluorescent equipment		
Lamp depreciation	0.85	0.49
Dust and dirt	0.77	
25 percent of lamps not operating	0.75	

Due to interception of light by operator's body, machine parts and materials, no light above 45° from the vertical should be included. Therefore, if the point-by-point method of calculation is used do not include candlepower above 45°. (If the average flux method of calculation is used, the factor $\frac{\text{light flux 0-45°}}{\text{light flux 0-90°}}$ must be included.)

DAVIS H. TUCK

is a graduate of Massachusetts Institute of Technology, 1911—Worked in the photometric laboratory of the National Bureau of Standards and then was transferred to the U. S. Public Health Service making studies of occupational diseases in industry—In 1918 became industrial and electrical engineer for the Holophane Company, Inc., New York, and since then has developed and patented many new and revolutionary lighting tools, such as the High Bay type of lighting, Crane Lights, special lights for specialized industry including the explosives, synthetic rubber, oil refinery, steel, and chemical industries.

Point-by-Point Method

The point-by-point method of calculating footcandles is based on the inverse square law and Lamberts law (the illumination at any point varies directly as the candlepower from the source in that direction and inversely as the square of the distance from the source to the point and directly as the cosine of the angle of the incident light). The most convenient forms of the formulae are:

$$\text{Footcandles horizontal} = \frac{\text{candlepower at angle a}}{h^2} \times \cos^3 a \times D$$

$$\text{Footcandles vertical} = \frac{\text{candlepower at angle a}}{h^2} \times \sin a \cos^2 a \times D$$

Where h is the vertical distance from the luminaire to the work and a is the angle formed by the vertical line through the luminaire and a line drawn from the luminaire to the work, D, is the depreciation factor. (Fig. 1.)

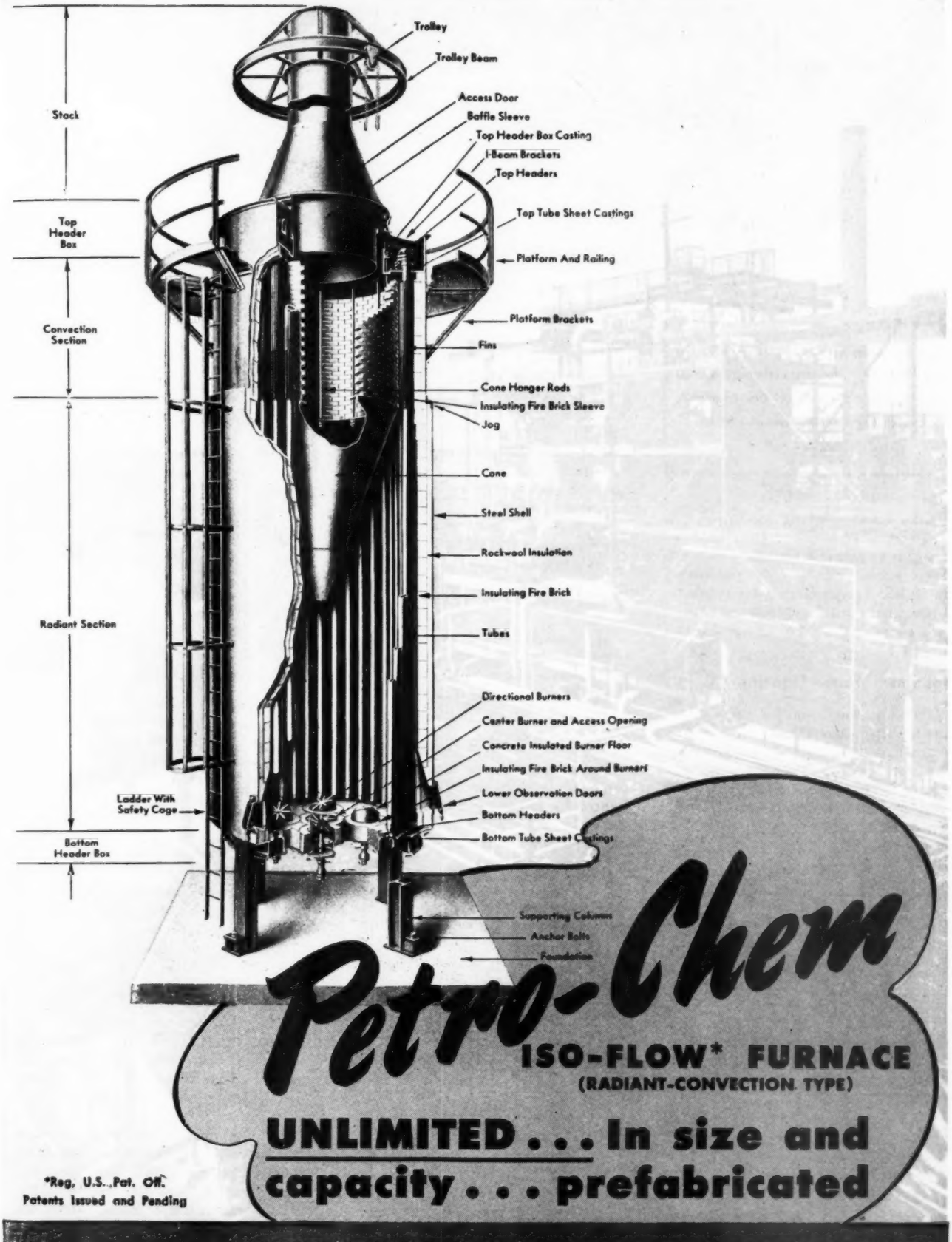
Simplified Calculating Method

Being familiar with operating conditions of various industries and the kind of lighting now in service in the best modern plants a figure of watts per sq. ft. of floor area can be given for each location that will include all variable factors and will be a measure of the "under working conditions" lighting level. For the purpose of this practical discussion the required watts per sq. ft. of floor area and the resulting foot-

TABLE 2

LAMP DATA

Lamp size, watts	*Lumens, initial*	*Multiplying factor depreciation, 70 percent of life*	*Light center, length*
50 I.F.	660	0.92	3⅛
60 I.F.	834	0.94	3⅛
100 I.F.	1580	0.88	3⅞
150 Clear	2610	0.88	5¼
200 Clear	3640	0.86	6
300 C. med. base	5850	0.84	6
300 C. mag. base	5650	0.83	7
500 Clear	9850	0.82	7
500 Bi Post I.F.	9750		4
750 Clear	15000	0.90	9½
750 Bi Post I.F.	14000		5½
1000 Clear	21000	0.83	9½
1500 Clear	33000	0.70	9½
400 Mercury	16000	0.82	7¾



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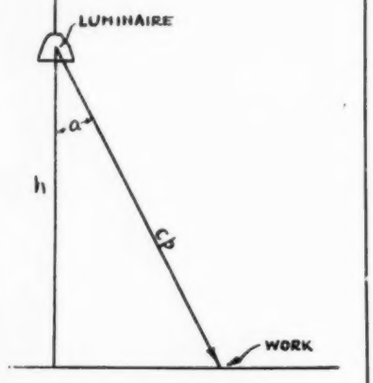

Fig. 1. Relation of h, a, luminaire and work. The candlepower at angle a is taken from the distribution curve of the luminaire in question

candles under working conditions will be given. This is the method used for specifying lighting for the new synthetic rubber plants. (Material covering lighting requirements for synthetic rubber plants will be supplied on request to engineers who are interested in this subject.)

Boundary Fence Lighting

Protective lighting for the war industries has been standardized. (See War Department Spec. No. 6403-E.) For fence lighting, space 300-watt multiple or 6000-lumen series lamps in two-way or C-way refractors on 150-ft. centers, mounted 25 ft. above grade. The illumination will be 0.2 footcandles or eight times full moonlight. Place poles 4 ft. inside fence line and mount refractor unit on a 4-ft. span bracket to bring the unit directly over the fence line (this placing prevents veiling glare due to light on the inside vertical surface of the fence). Series circuits are ordinarily used when the fence line is more than a mile long and multiple circuits used for lines less than a mile long. Overhead wiring is ordinarily used. (See Fig. 2.)

Gate and Guard House Lighting

The lighting at entrance gates should be increased so that the guards can see and recognize truck drivers and helpers and others who may enter the gate. It is necessary also for this lighting to be adequate for reading passes and making notes on records. This kind of lighting is best accomplished by placing two poles inside the gate on a circuit controlled from the guard house and separate from the fence lighting; 500-watt lamps in symmetrical two-piece refractors should be mounted 25 ft. above grade and placed as shown in Fig. 3. The illumination will be 2 footcandles and it is important that the illumination inside the watchman's house be no greater than 10 footcandles and of glareness quality so that his eyes will be in condition to see quickly and well when he comes out of his house. For guard house allow 2 watts per sq. ft. floor space. Use refractor with 150-watt lamp. (See Fig. 3.)

Roadway Lighting

Roadways that are main thoroughfares inside refineries should be well lighted for safety, protection, and convenience. C-way refractors equipped with 300-watt multiple or 6000-lumen series lamps spaced on 150-ft. centers and mounted 25 ft. above grade should be used. At road intersections place an additional refractor of the symmetrical type with 500-watt or 10,000-lumen lamp. The poles should be set back from the road.

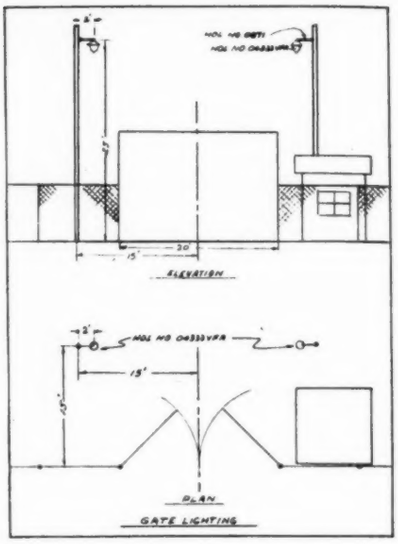

Fig. 3. Plan and elevation of gate lighting

Walk Path Lighting

Walk paths leading from one building to another or to important plant locations are lighted with a multiple circuit because small lamps are used and the distances involved are relatively short. Small symmetrical refractors are used with 150- or 200-watt lamps and spaced on approximately 100-ft. centers. The mounting height above grade is approximately 18 ft. The illumination will be 0.2 footcandles. Circuits are taken from nearby buildings. One of these units should be placed over doors opening to the outside. (See Fig. 4.)

General Yard Lighting

The area between buildings, stills, towers, tank farms, etc., should be lighted so there are no dark pockets. Such lighting is a protection against fire, sabotage, accidents, and theft and is general refinery practice. The equipment most suitable for this application is the two-piece refractor having either a 360°, 270°, or 180° light distribution. The units are equipped with 300- or 500-watt multiple lamps spaced not to exceed 200 ft. and mounted approximately 25 ft. above grade on brackets.

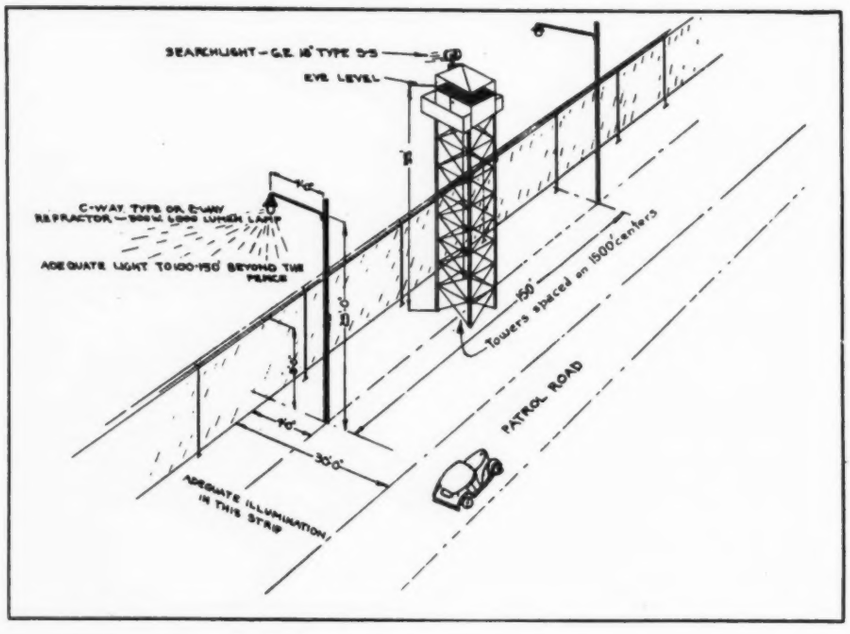
SEARCHLIGHT – G.E. 18" TYPE 'DS'
EYE LEVEL
C-WAY TYPE OR E-WAY
REFRACTOR – 300 W. 5000 LUMEN LAMP
ADEQUATE LIGHT TO 100-150' BEYOND THE FENCE
Towers spaced on 1500' centers
150'
PATROL ROAD
30'-0"
ADEQUATE ILLUMINATION IN THIS STRIP

Fig. 2. Good practice in fence lighting

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THREE Welds

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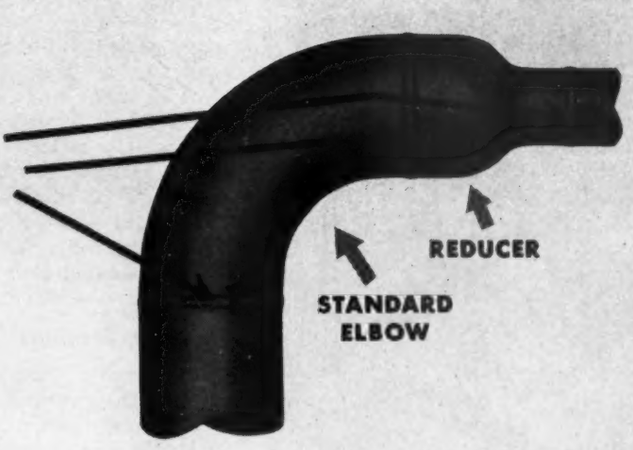

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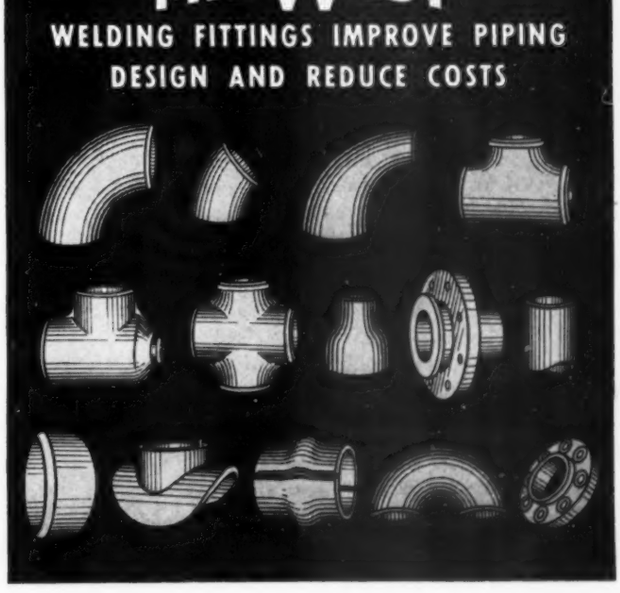

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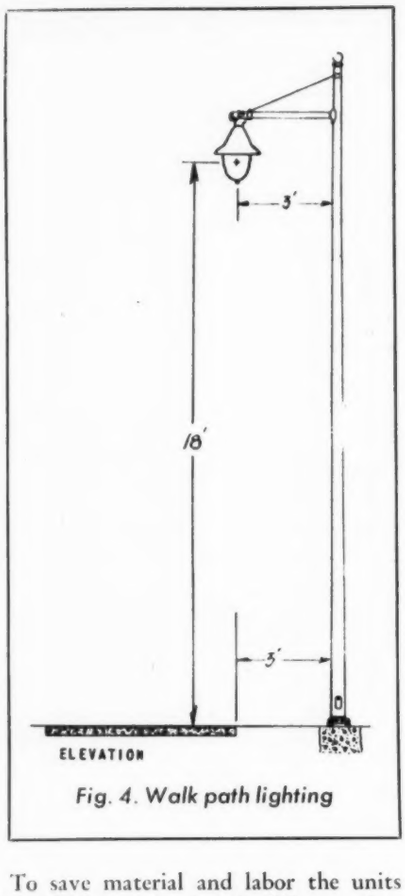


Fig. 4. Walk path lighting

To save material and labor the units should be mounted on buildings, existing poles, or other structures whenever possible. By the judicious placing of these lights important process areas can be lighted as well as the yard space in general. Special attention should be given to dark pockets between buildings, towers, etc. It is advantageous to place units on the corners of buildings so the areas on both sides of the building can be lighted from the one unit using a 270° light distribution. Fig. 5 shows how units can be placed to advantage.

Locker Change

The locker building is a most important one from the standpoint of plant efficiency, as it is the point of entrance and exit for all shop personnel. Guards stationed at points marked G require strong localized light; use 200-watt lamps. For the captain of the guard's office, light as for "Office Space." Time cards need vertical lights on the rack; use a special vertical surface unit with 150-watt lamp on 8-ft. centers at ceiling. Locker rooms should be similarly treated. For passageways, showers, and toilets use 150-watt lights, allowing 4 watts per sq. ft., to provide 15 footcandles. Exterior doorways should have 200-watt units on brackets mounted 12 ft. above grade. Two such units should be placed at each side of the gate. (See Fig. 6.)

Loading Racks

Loading racks should be lighted for night service. The footcandle requirements are not high (about the same as gate lighting) because the attendants' eyes are dark-adapted and no close work is done. Use refractors with 200-watt lamp, mounted 15 ft. above the platform and spaced on 20-ft. centers for trucks and tank car loading. For ship loading use refractors with 500-watt lamps, mounted 25 ft. above the platform and space on 30-ft. centers.

Pumping Stations

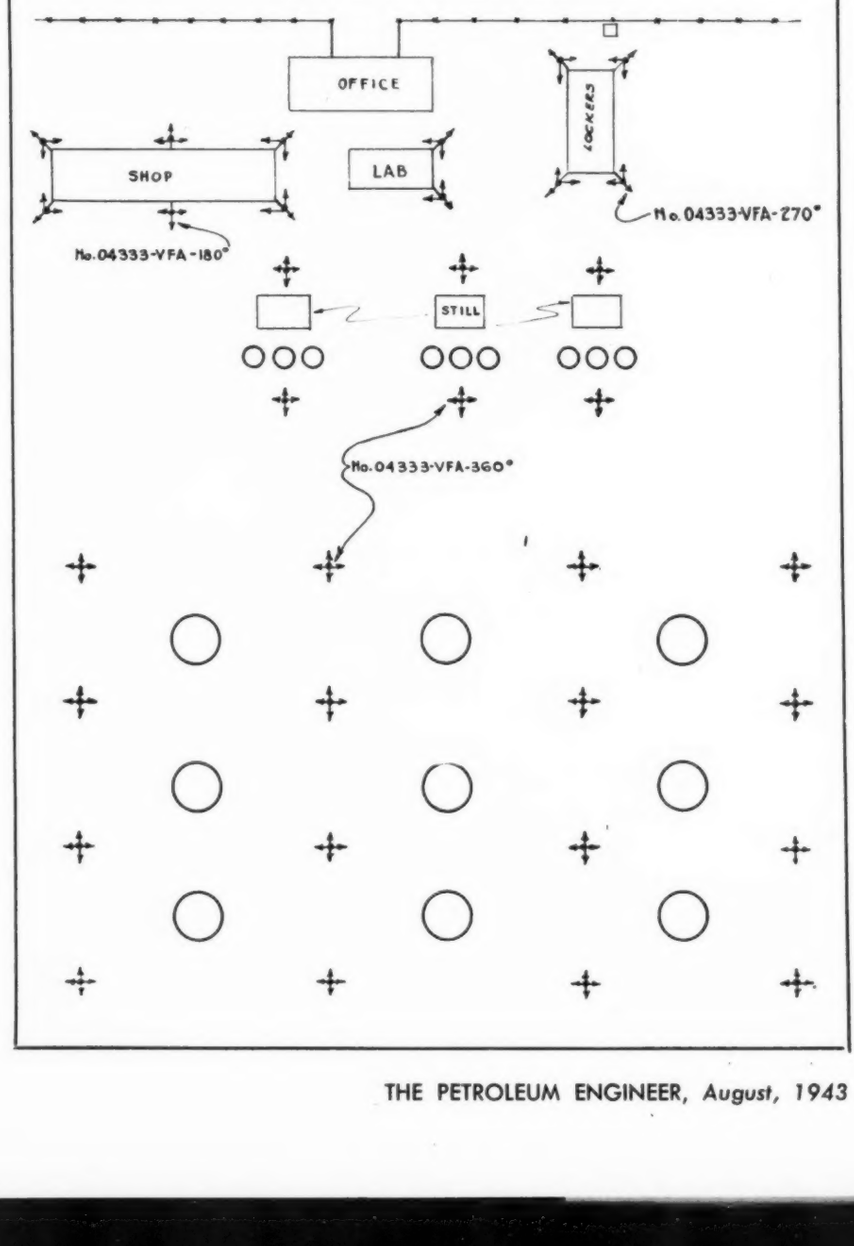
Pump stations on pipe line are spaced an average of 40 miles apart. In very rugged mountainous country they may be as close as 15 miles apart. The buildings are approximately 30 ft. wide and 100 ft. long with open truss construction having a height from floor to truss of approximately 20 ft. For routine operation the footcandle requirements are low although for repairs they are higher. These pump stations are vulnerable locations and adequate protective lighting should be provided. For general lighting allow 2 watts per sq. ft. of floor space arranged on two circuits to give 5 footcandles for routine operation and 10 footcandles for repairs. Use refractors with 200-watt lamp, mount as high as possible (on roof trusses). For protective lighting use refractors with 500-watt lamp on opposite corners of the building.

Refinery Pumps

Refinery stock pumps are employed to pump hot stock at high pressures. The lighting should be of medium footcandle value. Explosion-proof lighting requirement of Class I, Group D, is usually employed. Allow 2 watts per sq. ft. of floor space to produce 5 footcandles under operating conditions. Use an approved type of explosion-proof lighting unit for 200-watt lamp.

When pump-houses are well ventilated, or are not housed, Class II, Group G lighting equipment is used.

Fig. 5. General yard lighting



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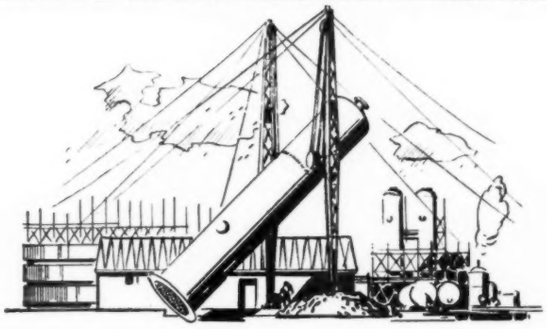

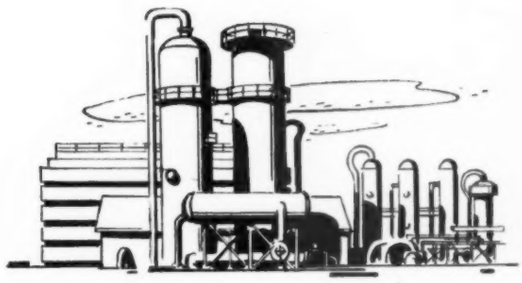

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For inside application use equipment with a seal-off fitting and 200-watt lamp. Allow one watt per sq. ft. of floor space to produce 5 footcandles under operating conditions.

For outdoor pump locations use equipment with 200-watt lamp. Mount poles 15 ft. above grade and space on 20-ft. centers.

Control Room

Two types of control rooms may be considered, depending on whether the instruments operate by remote control.

Instrument boards require vertical illumination and the light must be incident on the glass at an angle of approximately 75° from the normal to prevent back specular reflections from obscuring the meter faces. Exposed or inbuilt control lens units are used for remote control types of board and similar units with approximately 4 lb. per sq. in. of air pressure inside the box are used for direct operating boards. When the board is of the remote control type the unit used is one for flush mounting, and a 300-watt lamp is used in each unit. The vertical illumination will be 15 footcandles under operating conditions.

A compressed air connection must be made to explosion-proof units so that the inside of the unit is continuously flushed out with fresh air, thereby preventing an accumulation of explosive vapors inside the unit. The conduit entering the box should be sealed off.

Similar lighting units using fluorescent lamps have been used in isolated cases but the illumination is considerably lower and less uniform and the equipment is more expensive in both first and operating cost. (The fluorescent explosion-proof type has been used extensively for lighting large paint spray rooms in the airplane industry where lighting is required largely on horizontal surfaces.)

Pipe Still

Lighting is required over and under the platform of a pipe still and should be of the outdoor type Class II, Group G construction. Low footcandle value is sufficient. Fig. 7 shows location and types of equipment.

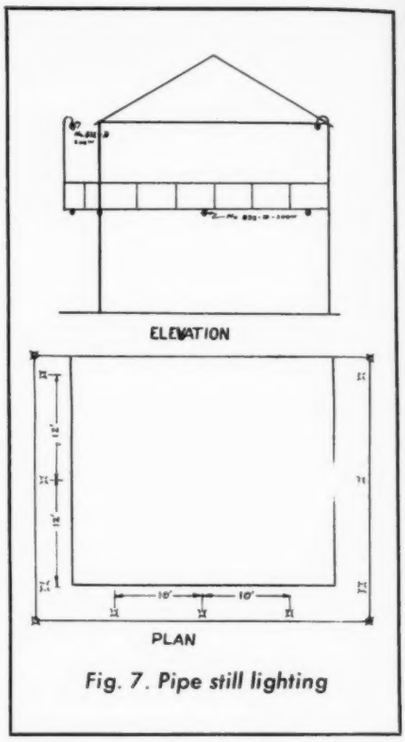
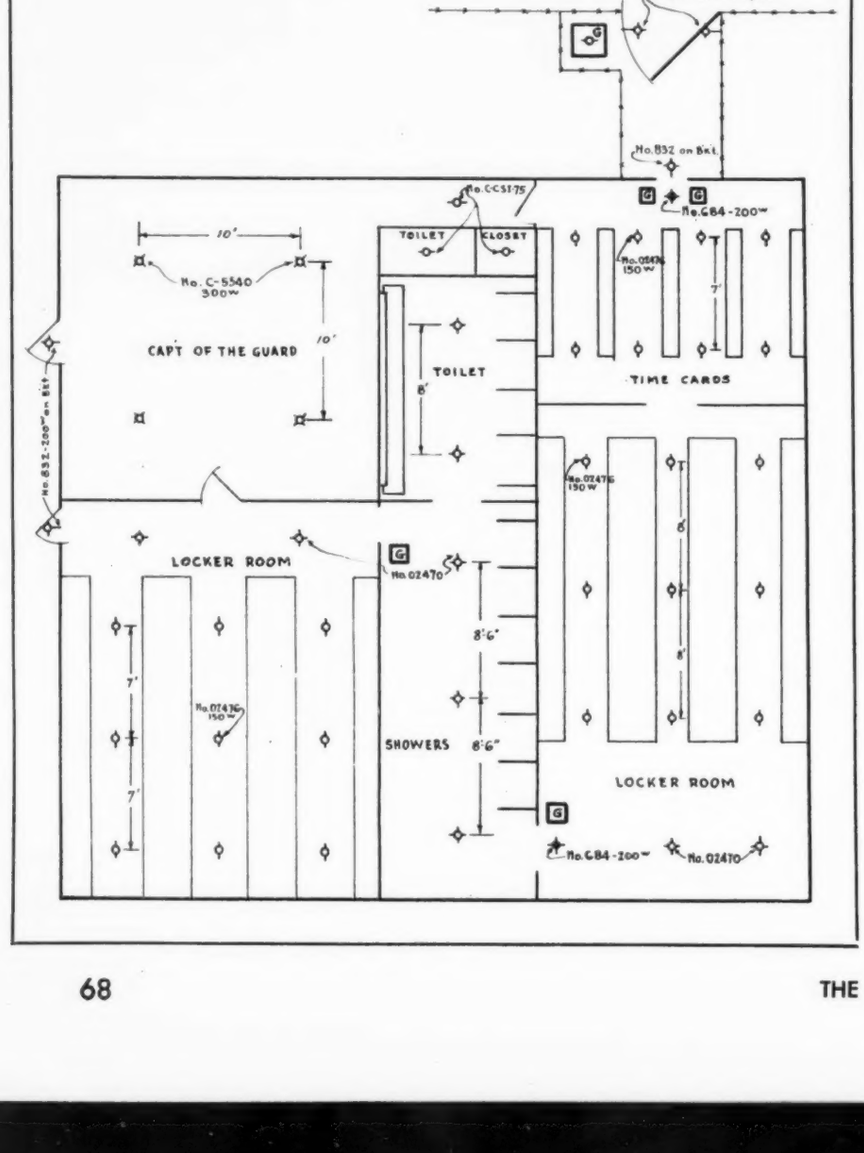


Fig. 7. Pipe still lighting

Fig. 6. Plan of typical locker change house lighting

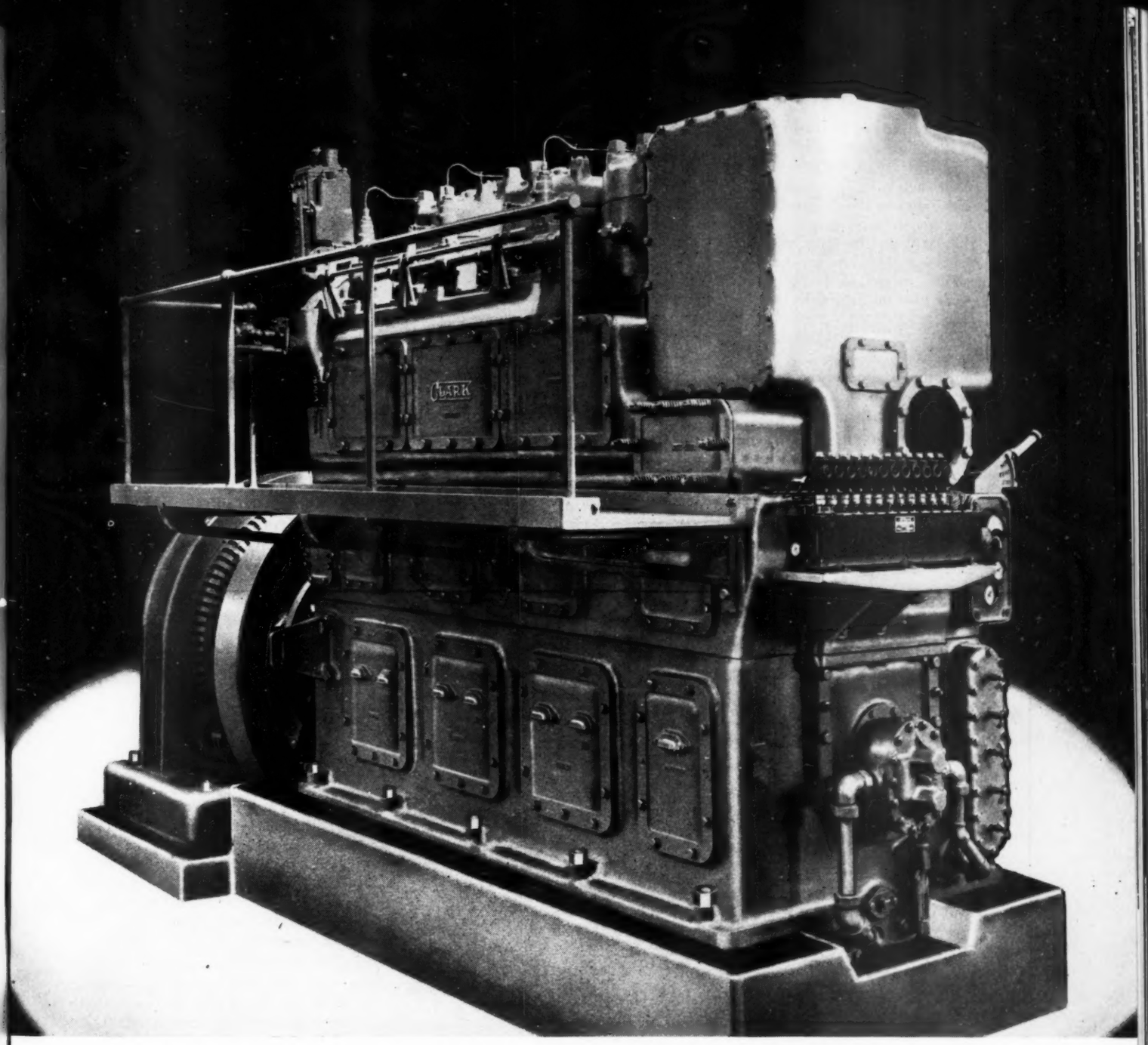


Other Equipment

Bubble towers, stripping towers, vaporizers, reactors, evaporators, and condensers vary in height and diameter not only regarding the type of tower, but different plants may have towers of different dimensions for the same use. Various draw pipes, feed pipes, steam and heat exchanger pipes tap into the tower at different levels. All towers have platforms at various levels connected by ladders or stairs. Lighting is required at each platform level. Locations for platform lights should be chosen to take care of stairs without glare in the eyes of an operator going up or down and to give additional illumination to some important valve, or gauge.

The lighting units should be of the outdoor Class II, Group G type for 100-150-watt or for 150-200-watt lamps. The distribution of light from these rugged refractor units is well-suited for the application where vertical light over large areas is important. Of equal importance is the rugged cast-iron hood construction and the two-piece glass refractor made of heavy pressed glass. The two-piece construction allows both interior and exterior surfaces to be smooth glass for easy maintenance and the refracting prisms are permanently sealed in an airtight chamber.

In most cases there are two or more towers close together (less than 50 ft. apart) so that the lights on the cat-



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walks of one tower can be used to light the catwalk on the adjacent tower, thereby reducing the number of lights required. In such cases it is desirable to stagger the lights on the different levels always keeping in mind to place lights where they will do the most good. A symmetrical layout is not necessary or even desirable in practical application regardless of how well it might look on paper. (Fig. 8.)

Dimout

The object of dimout is to prevent sky glow or direct lights that can be seen from the ocean, against which submarines can sight a ship by its silhouette.

When an oil refinery is in a dimout zone the lights must be made to comply with the local army dimout regulations. These regulations vary in minor details in the different command areas but are of uniform intent in that:

1. All lights that give direct light toward the ocean must be shielded to entirely eliminate this direct light. This is usually accomplished by opaquing (with black paint or a fiber shield) the glass portion of the light toward the ocean.

2. No light should be emitted above the horizontal (in some areas no light above 35° below the horizontal—check this point with the local regulations by the army). This is usually accomplished by a fiber shade that slips over the fixture.

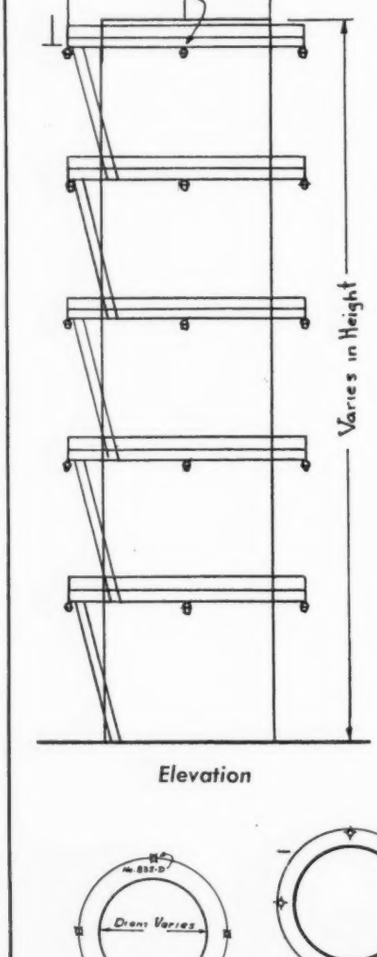


Fig. 8. Bubble tower lighting

Blackout Lighting

Blackout lighting is intended for use during a blackout and has been developed mainly from the British experience to provide light for safety and morale but not visible from the sky during an air raid.

The U. S. War Department has approved two types of blackout lighting equipment for two different types of service and no others may be used.

Inside Blackout Lighting

Inside blackout light is the 14-watt, A-15 bulb known as "Indoor Blackout Lamp." This bulb has an opaque coating except for a 1-in. diameter aperture at the end of the bulb, the aperture being coated to emit orange light. These lamps are approved by the War Department and are marked "Indoor Blackout—War Department Standard."

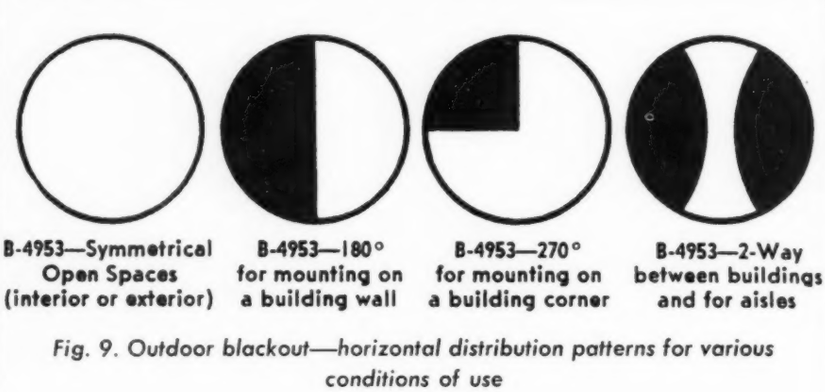

B-4953—Symmetrical Open Spaces (interior or exterior)
B-4953—180° for mounting on a building wall
B-4953—270° for mounting on a building corner
B-4953—2-Way between buildings and for aisles

Fig. 9. Outdoor blackout—horizontal distribution patterns for various conditions of use

Must be used in accordance with the following instructions to meet War Department blackout requirements:

1. In any room, only one unit is permitted to each 200 sq. ft. of floor area or fraction thereof.

2. Units shall be spaced not less than 10 ft. apart in any direction.

3. In corridors, one row of units is permitted at a spacing of not less than 15 ft.

4. Units shall be placed at least 3 ft. from any window, exterior door, or other opening.

5. When openings are covered in the usual manner with drawn window shades, draperies, blinds, or even with one thickness of newspaper, or whenever each unit has a shade that screens the unit from outside observation above the horizontal, units may be installed at any height.

6. When exterior openings are not covered, and when units are not otherwise shaded from outside observation above the horizontal, blackout units shall be placed above the top of such openings.

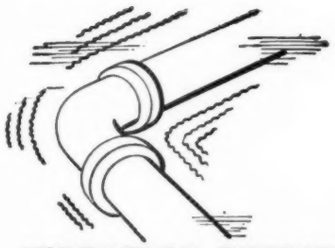
Outside Blackout Lighting

The outside blackout lighting unit bears the marking "Street Blackout—War Department Standards 16542." This unit has a cast-iron hood tapped ½-in. female pipe thread. The glass is of the shatter-proof type so that if broken by violent impact it will not splinter but will crumble harmlessly. The outdoor blackout lamp has a 9-watt bulb and a medium screw base for outdoor blackout units. In accordance with War Department specifications the unit should be spaced more than 100 ft. and preferably not less than 150 ft. apart. The mounting height should be 20 ft. or greater above grade. The resulting illumination will be 0.0003 footcandles (starlight on a clear night). (See Fig. 9.)

☆ ☆ ☆

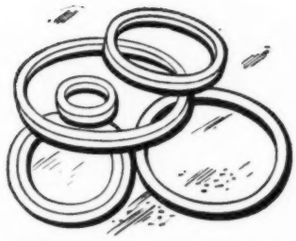
How to eliminate these piping troubles that hamper war work:

Weld with TUBE-TURN WELDING FITTINGS



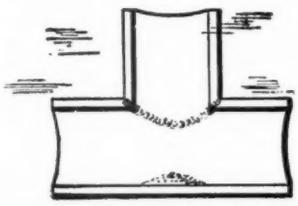
VIBRATION EFFECTS

You need never worry about vibration or strain loosening a *welded* joint.



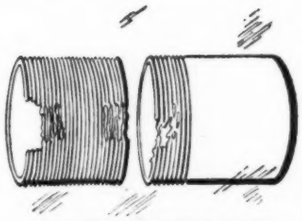
GASKET CHANGES

Fewer flanged joints mean less gaskets—save materials and time.



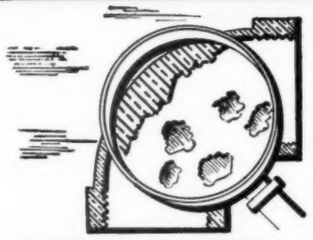
SLAG ACCUMULATION

Butt welds with Tube-Turn fittings virtually eliminate danger of slag.



WORN THREADS

Threading thins and weakens metal—causes failures.

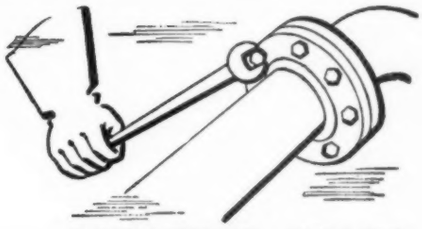


RAPID CORROSION

Tube-Turn fittings resist corrosion because of better metal structure.

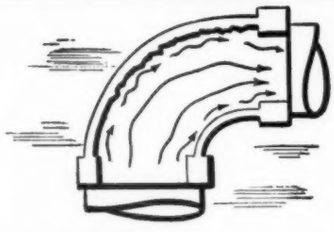
LEAKAGE REPAIRS

No chance of loose connections or leaks with Tube-Turn fittings.



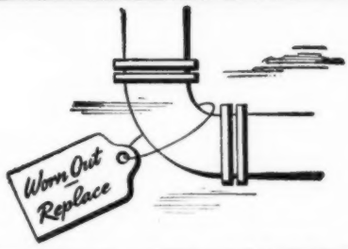
LOOSENED BOLTS

The more welding fittings used, the fewer bolts there are to tighten.



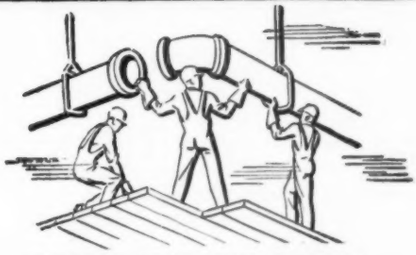
INEFFICIENT FLOW

Easy sweeping radius and no offsets inside mean less pressure loss.



FITTING REPLACEMENT

There's far less time loss or replacement expense with Tube-Turn welding fittings.



SLOW INSTALLATION

Tube-Turn fittings line up perfectly; allow fast, simple. easy butt welding.

NO. 3 OF A SERIES

HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY

The FIRST WELDING FITTINGS 1ST AND STILL THE BEST

TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

Tube Turns (Inc.) Louisville, Ky. Branch offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Tulsa, Houston, Los Angeles. Distributors in principal cities.

Power Factor Correction Increases Output of Electrical Equipment

PETROLEUM ENGINEER Exclusive Feature

☆ Materials being scarce, it is important to obtain as much work as possible from existing installations

by E. H. Lamberger

Petroleum Engineer, Westinghouse Electric and Manufacturing Company

PRACTICALLY all oil-field equipment is composed wholly or to a large extent of vital defense materials, making replacements or additions difficult to obtain. It is important, therefore, that everything possible be done to permit existing equipment to carry as great a load as practicable, so that the necessity for additional equipment will be kept to a minimum.

One way of increasing the useful work that can be done by oil-field electrical generating and distribution equipment is by power factor correction, thereby making the full current capacity of such equipment available for useful work.

Meaning of Power Factor

The power factor of a motor is the ratio of the power current to the total line current, which is composed of the power current and a magnetizing current. Due to the presence of the magnetizing current, which is indispensable, the line current is not fully effective in carrying kw.- or hp.-load. The power factor expresses the effectiveness of the line current in carrying kw.- or hp.-load. Consequently, if a generator is carrying a full current load at 80 percent power factor, it means that only 80 percent of the generator capacity is doing useful work. If the power factor of the load were raised from 80 percent to 100 percent the generator could carry one-fourth more kw.- or hp.-load, and would be doing useful work to its full capacity.

A wattmeter indicates the actual useful load being carried by the line current, as it automatically multiplies only the power component of the line current by the line voltage. The volt-ampere load is the product of the line voltage, the line current and a factor 1.73 for three-phase circuits, and is expressed as kva. when the product is divided by 1000. The wattmeter reading divided by the volt-ampere value gives the ratio of useful to total load, this ratio being the power factor of the load.

If a given kw.- or hp.-load is carried by a generator at 100 percent power factor, the generator line current is a minimum and the kva.-load numerically equals the kw.-load. For any power factor less than 100 percent, the current and kva. are inversely greater. Thus, a 50 percent power factor would impose a current and kva.-load on the generator twice the minimum possible for the kw.- or hp.-load carried. The installed kva.-rating of the generator must, therefore, be double the kw.-load carried. The rating of the generator must be based on the line current load (for any given voltage) as the load-carrying ability of the machine is determined by the permissible temperature rise, and the temperature rise is a function of the total losses in the generator, of which losses those due to line current (I^2R) are a very important part.

E. H. LAMBERGER

is an application engineer in the petroleum and chemical section of the industry engineering department of Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania—Since 1936 his activities have been mainly directed toward the production of petroleum, assisting in such developments as variable voltage d-c. drilling equipment, a-c. drilling equipment, and all types of oil-well pumping—He has been with Westinghouse since 1921, the year he was graduated from Ohio State University in electrical engineering.

Cause of Low Power Factor

As motors used for pumping are of the induction type, and have characteristics that produce specially high starting torques, their rated full load power factor must be relatively low. Furthermore, the load of a pumping well is a cyclic one with loads ranging from high peak values, probably beyond the rating of the motor, down to practically no load or even a slight negative or regenerative load. As the magnetizing current of the motor is constant, the power factor at light loads must be low, without equivalent improvement at the overloads. The cyclic pumping load, therefore, will have an average power factor that is lower than the rated value. This is illustrated by Fig. 1, which is taken from an actual test with a 25-hp., 8-pole normal-slip, high-torque pumping motor. It is apparent that lightly-loaded motors in a field will tend to lower the overall power factor of the total load carried by the power station.

Overall Load Power Factor

Field tests on 8-pole motors have shown that the average power factor for a complete pumping cycle will approximate 65 percent for normal-slip, high-torque pumping motors and 75 percent for high-slip, high-torque pumping motors. The power factor of the high-slip motor is inherently higher due to a lower magnetizing current, a higher internal resistance, or a combination of these two factors. The average values would be slightly higher for high-speed motors.

When both types of motors are used, an approximation of the combined power factor of the load may be arrived at by determining the weighted average value based on motor hp. Example:

Total high-slip motor hp. 65, power factor 75 percent.
Total normal-slip motor hp. 50, power factor 65 percent.

$$65 \times 75 = 4875$$
$$50 \times 65 = 3250$$
$$115 \quad = 8125$$

$8125/115 = 70$ percent average power factor.

The effect of the distribution system, including transformers, on the power

CHECK FORMATION VALUES

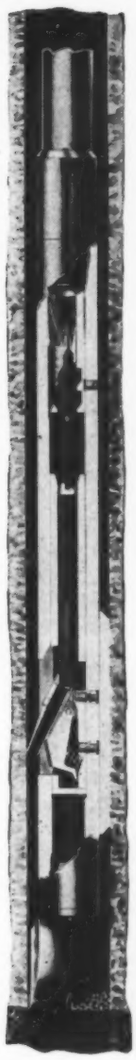
Quickly, Surely at Low Cost!

HUNT SIDE WALL CORING TOOL

1.

2.

3.



4.

5.

Here's the modern method so many successful operators depend on to get the true facts on uncored formations. The Hunt Side Wall Tool gets real cores—up to 1¾" diameter, 8" length—not just samples!

1. **The tool with wire line barrel in position to take core**
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3. **Circulation plug**
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HUNT TOOL COMPANY

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Houston, Bay City, Corpus Christi, Jennings, Shreveport, Harvey

EXPORT SALES:
W-K-M Company, Inc.
74 Trinity Place, New York City

HUNT TOOL COMPANY

HOUSTON, TEXAS, U. S. A.

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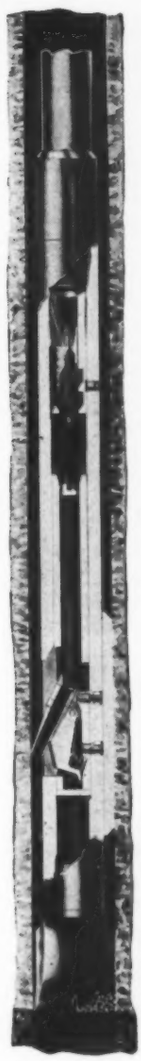

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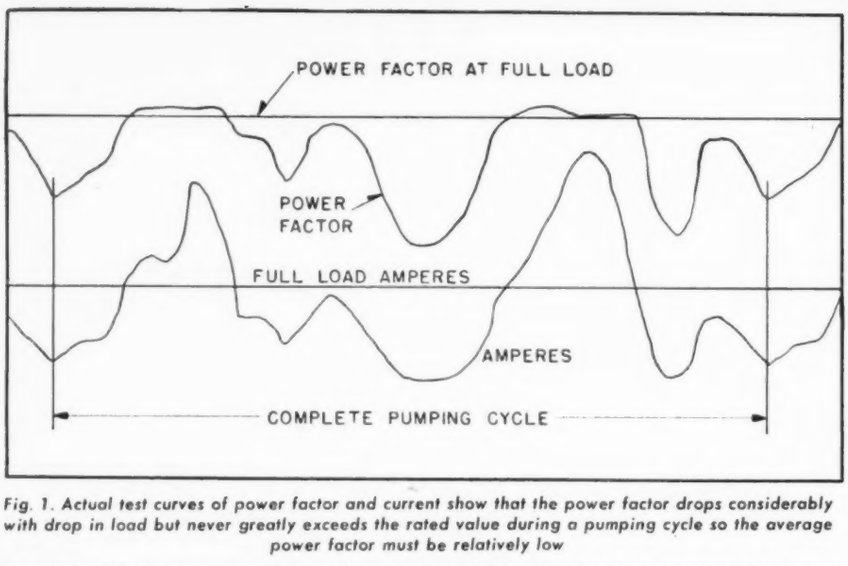


Fig. 1. Actual test curves of power factor and current show that the power factor drops considerably with drop in load but never greatly exceeds the rated value during a pumping cycle so the average power factor must be relatively low

factor at the generator may be neglected. The overall effect for a typical lease with 20 motors with ratings ranging from 5 to 20 hp. and including both normal-slip and high-slip motors was calculated to be less than 1 percent.

Correcting the Power Factor

The source of poor power factor is in the load and not in the generator. Power factor correction consists, in effect, of supplying the magnetizing current required by the load by a means external to the generator. The means best suited to the oil fields is the capacitor. Actually, the capacitor also draws current from the generator, but this is a "leading" current and counteracts the "lagging" magnetizing current of the load. The leading current is negative relative to the lagging current; so if the two are numerically equal their algebraic sum is zero. In effect, the generator is then relieved of carrying any magnetizing current, and its full current capacity is available for work —kw.- or hp.-load. Fig. 2 shows graphically the relation of line current to the power and magnetizing components, and the corrective effect of the current drawn by the capacitor. It is apparent that over-correction is possible, as capacitor current in excess of the magnetizing current of the load will again result in a power factor less than unity.

Area of Capacitors' Effectiveness

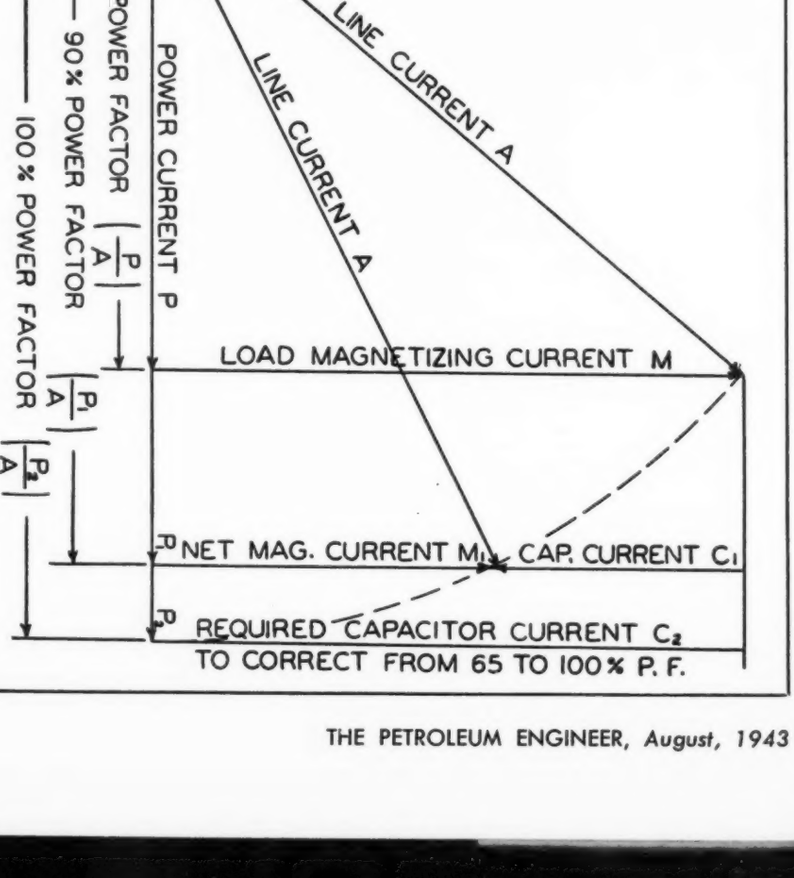
The capacitors may be installed at the power source, such as the lease generating plant or a transformer bank for utility power, at various points in the lease distribution system or at the motors.

The corrective effect of the capacitor exists from the capacitor to and including the ultimate generator. This is illustrated by Fig. 3. There is no corrective effect of the capacitor toward or in the motor; therefore, capacitors do not increase the load-carrying ability of the motors. Capacitors placed at the motors, however, do increase the kw.- or hp.-capacity of the distribution system, including transformers, as well as that of the generating station, including the control and switching equipment. Weatherproof capacitors are available for mounting on poles at the motors. Should the distribution system be entirely adequate from the standpoints of line losses and voltage drop, and only improvement of current conditions at the generator are needed, the capacitors may be grouped in the generating station.

Capacitors Necessary

The amount of capacitors necessary depends upon three factors, namely: (1) the kw. value of the load carried, or to be carried, (2) the existing power factor of the load, and (3) the desired improved power factor. Fig. 4 offers a commonly used convenient method for quickly determining the kva. rating of capacitors, when these three factors have been established. For example, assuming that a 115-hp. motor load (100-kw. generator output) at 70 percent power factor is to be corrected to 90 percent power factor, the required capacitor rating in kva., is 54 percent of 100, the load in kw. or 54 kva. If correction to 100 percent power factor is to be made, the intersected percentage happens to be 100, and therefore 100 kva. of capacitors would be required.

Fig. 2. Diagram of how capacitor corrects low power factor. Power factor correction consists of counteracting the magnetizing current of a load with a corrective current, so that in effect, the generator and the distribution system between generator and capacitor are relieved of carrying the magnetizing current or a portion thereof. With power factor correction to 100 percent the power component equals (and coincides with) the line current so the full capacity of the generator is available to carry kw. or hp. load


65% POWER FACTOR (P/A)
90% POWER FACTOR (P1/A)
100% POWER FACTOR (P2/A)
POWER CURRENT P
LINE CURRENT A
LINE CURRENT A
LOAD MAGNETIZING CURRENT M
NET MAG. CURRENT M1
CAP. CURRENT C1
REQUIRED CAPACITOR CURRENT C2
TO CORRECT FROM 65 TO 100% P. F.

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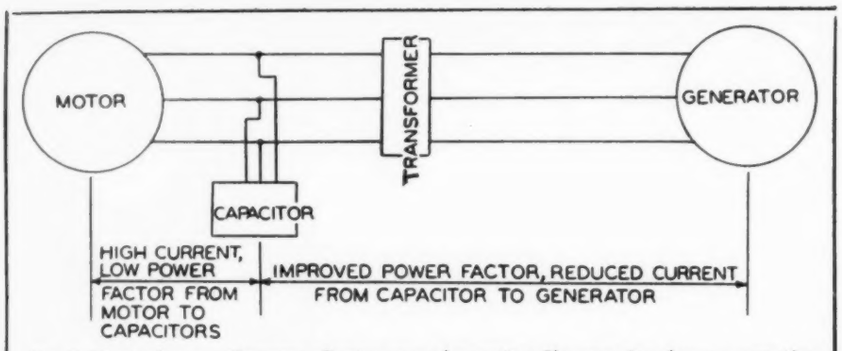


Fig. 3. Circuit diagram illustrates effective area of capacitor. The capacitor draws a corrective current from the generator, therefore the improvement of power factor and reduction in current for a given hp. load exists from the capacitor to and including the generator. The capacitor has no effect on the power factor or current between the capacitor and motor

Effect of Engine Load

Engine loading will not be increased by improving the power factor unless additional kw.-load is added. In fact, the engine loading will be reduced because of the reduction in losses in the generating and distribution equipment incident to the lower line current. Should additional kw.-load be added, proportionately greater engine capacity must be made available. In some cases, existing engines may have adequate margin to carry the increased hp.-load, during the national emergency, and in other cases supplemental or larger units may be required. In any event, the requirement for vital materials to carry the additional load is limited to that for capacitors and possible increased engine capacity.

Examples of Increased Loads

A 100-kw. pumping load with 65 percent power factor possibly is now being carried by a 65 percent power factor generator, or by an 80 percent power factor machine.

The maximum kva. rating of the 65 percent machine would be $\frac{100}{0.65} = 154$ kva. By correction to 80 percent power factor this machine would carry $154 \times 0.80 = 123.2$ kw., and would require 42 percent of $123.2 = 52$ kva. of capacitors. If correction is made for 100 percent power factor this machine would carry 154 kw. and would require 116 percent of $154 = 178$ kva. of capacitors.

If the 100 kw.-load is being carried by a generator designed for an 80 percent power factor load, the required kva. rating should be:

$$\frac{100}{0.65} \times \frac{1}{0.90} = 171 \text{ kva.}$$

The additional factor of $\frac{1}{0.90}$ is necessary because the lower power factor current (65 percent as compared to 80 percent on which the machine rating is based) has a demagnetizing action on the generator, which in the end means that a larger machine must be used to maintain full voltage at full current. By correcting to 80 percent power factor this machine could carry 137 kw. requiring 57.5 kva. of capacitors and by correction to 100 percent it would carry 171 kw. requiring 198 kva. of capacitors.

Cost of Correction

The capacitors may be mounted on the pole at the motor, being either of an outdoor type or of an indoor type

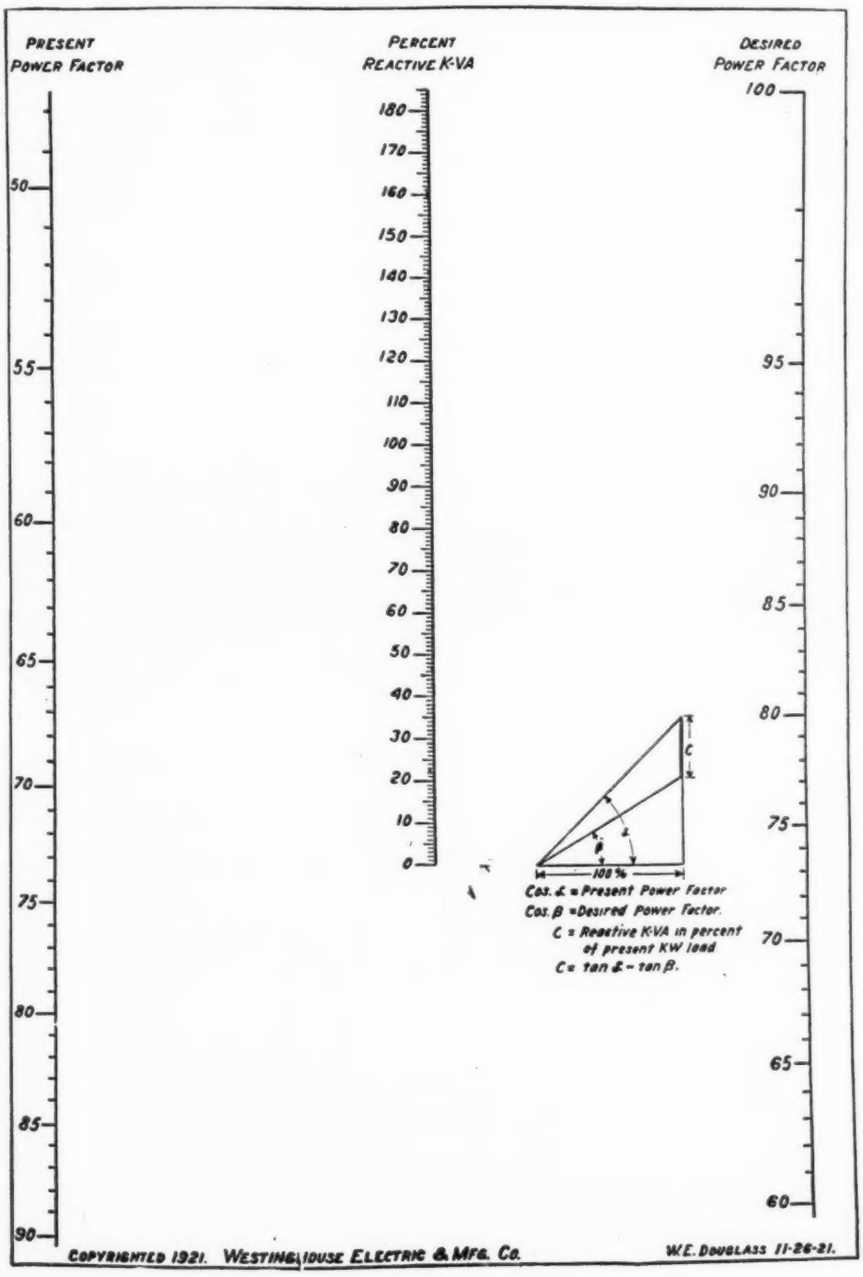
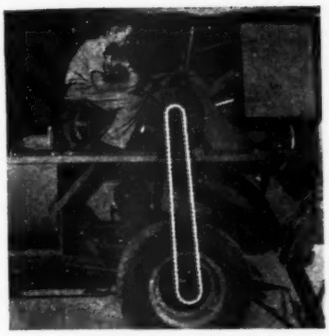


Fig. 4. Chart for determining amount of capacitors required. The corrective capacitor rating in kva. may be determined as follows: (1) connect the present power factor value on the scale at the left and the proposed power factor value on the scale at the right with a straight edge; (2) read the percentage value intersected on the middle scale; (3) this percentage of the kw. load to be carried gives the required capacitor rating in kva.

WIDE ACCEPTANCE *through* FINE PERFORMANCE



Oil well surveying truck

• Link-Belt Silverlink finished steel roller chain is the No. 1 choice of roller chains in so many oil industry applications today because of its unfailing performance assured by so many valuable features. In cooperation with the government conservation program, Silverlink roller chain will hereafter be furnished in a durable "blackout" finish.

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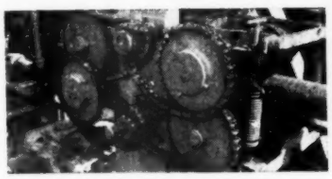
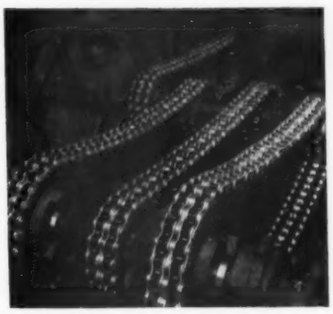
- Flexibility of operation
- Complete range of sizes
- Helpful engineering service
- 67 years' experience

Drive from engine to mud pump



Pipeline cleaning and coating machine



Rotary drawworks (heavy duty)

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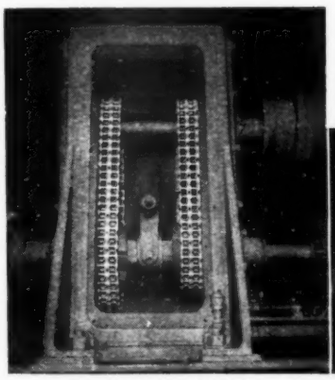
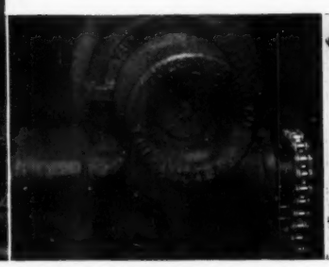
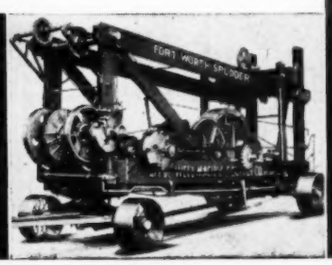
Also manufacturers of silent chain drives, rotary drilling chains, roller and ball bearings, and other transmission equipment, mud screens and cranes. 9084



Independent rotary drive

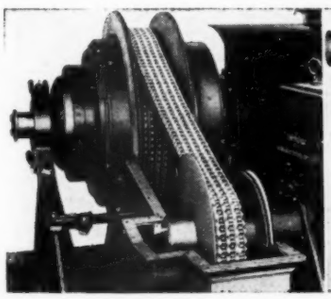


Truck mounted service winch

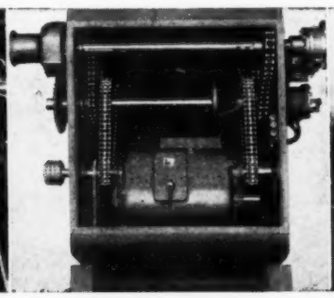


Cable tool spudder

Pipeline ditching machine

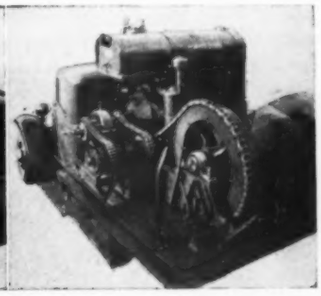


Torque converter drive



Light drawworks

Heavy duty transmission drive



Clean-out machine

LINK-BELT *Silverlink* ROLLER CHAINS

protected by an enclosure. They may also be grouped in the generating station. Depending on the size of the field, and the power supply voltage they may be of 460-volt rating or higher. All these factors affect the cost of the capacitor installation, but in no case would the overall installed cost exceed $10.00 per kva. and the range would probably be from $7.50 to $10.00 per kva., including cutouts, hangers, conduit, and labor. Normally, correction to 100 percent power factor may be too expensive to be economical, but under the present conditions it may be the only possible way to procure additional electrical capacity.

Additional Advantages

In addition to making it possible to carry an extra load with existing electrical equipment, other continuing advantages are obtained by power factor correction. These may be summarized as follows:

1. A number of wells may periodically get into step causing high peak current demands on the power supply. Such high current peaks, particularly objectionable when power is generated in a lease power plant, are minimized by power factor correction.

2. Most power companies place a premium on minimizing the average peak kva. demand over some prescribed period such as 15 minutes. An improvement in power factor will frequently result in a large annual saving in the power bill.

3. Reduced power consumption by decreasing power losses in the generating and distribution equipment.

4. Improved motor starting due to reduced line drop incident with lower line currents.

—— ☆ ☆ ☆ —

P 737.1

Cooling Refinery Air

☆ Determination of amount of mechanical refrigeration or ice required to cool refinery air

by W. F. Schaphorst

THE accompanying illustration is an interesting and valuable chart simplifying the determination of the amount of mechanical refrigeration or ice necessary to cool an amount of air in refineries. Development of the chart is credited to A. Lewis, chief mechanical engineer of the Commonwealth Works Department of Australia.

To apply the chart find the temperature of the air, using the figures at the bottom of the chart. Then follow the line representing the temperature to the point where it intersects the corresponding humidity curve for the air. Then follow the line horizontally to the scale on the right and note the figure corresponding to the heat content in B.t.u. per 1000 cu. ft.

If it is required to reduce the temperature of air 10° follow the reduced temperature line upward until it intersects the desired humidity and then run horizontally to the right and deduct the newly determined figure from the former. The difference is the number of B.t.u. that must be removed from the air.

With a pair of dividers or a slip of paper the distance between the two figures placed alongside the "vertical scale" shown on the chart gives the refrigeration required for 24 hr.

For example, how many tons of ice will be required per day to cool 1000 cu. ft. of air per min. having an initial temperature of 100° F. and 40 percent humidity to 90° F. temperature and 20 percent humidity?

3000 B.t.u. — 2000 B.t.u. =
1000 B.t.u.

The distance on the chart from 3000 to 2000 is slightly greater than the vertical scale distance representing 4 tons. In other words the answer is "almost 5 tons of ice per 24 hr."

Or, divide the 1000 B.t.u. by 218 and we get 4.6 tons as the exact answer.

In the event of any other quantity of air, results are directly proportional. Thus for 2000 cu. ft. of air per min. we would require 4.6 tons x 2 = 9.2 tons of ice per 24-hr. day.

For 10,000 cu. ft. of air per min., 4.6 x 10 = 46 tons of ice required per 24 hr.

—— ☆ ☆ ☆ —

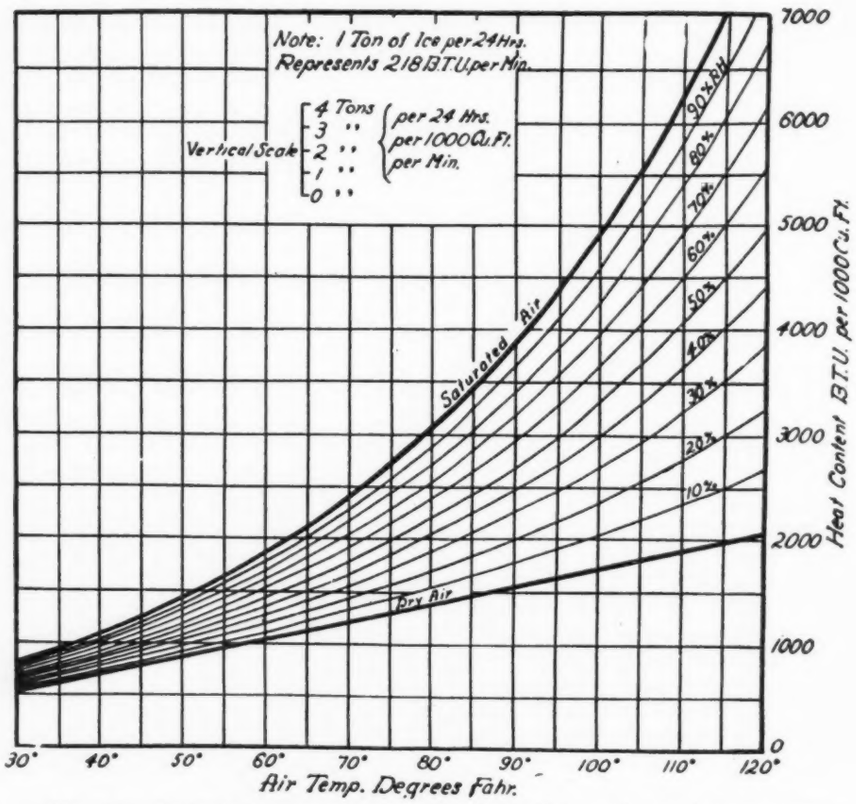
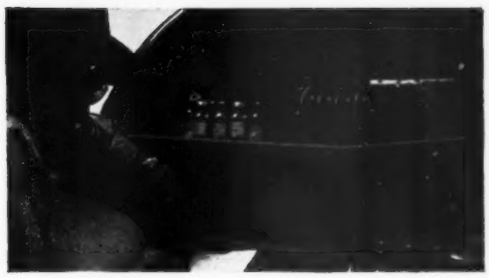


Chart for determining amount of mechanical refrigeration or ice necessary to cool a given amount of air

for the best in Dehydration



Tret-O-lite representatives are skilled in field testing methods. Their skill, plus many years of practical experience, enables them to render an unsurpassed advisory and dehydration service. This service is vital to efficient production for war. The high quality petroleum products now required can be at their best only when the oil has had careful treatment, from the time it is produced until it is ready for use. Tret-O-lite Service is designed to supply the first careful treatment.

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Whither Are We Bound?

PART 3 *(Concluded)*

PETROLEUM ENGINEER Exclusive Feature

by R. G. Lovell

Development Engineer, Hancock Oil Company of California

Cooling System of Car

As long as the engine, because of its weight, had of necessity to be placed in the front of the vehicle, there remained no room in which to put a cooler that could act as a steam condenser. Now, however, that we are whittling the engine down to perhaps one-third of its original weight and can, therefore, place it where it belongs—at the front of the unit—we have plenty of room for a properly designed steam condenser. This unit will not be any larger than the present radiator and can be of shape more in keeping with the streamline idea. There are several very interesting avenues of creative thought opened by this idea but their development belongs to the automotive engineer rather than the refinery man. One of these avenues has so persistently intrigued the writer that he will give it expression a little later on with the idea that other engineers may find something worthwhile in it. The aim of the idea is to make a virtue instead of a vice out of the necessity for streamlining an automobile.

Increased Need for Streamlining

The notion has been prevalent that a considerable reduction was made in the power necessary to drive a car by careful attention to body design aimed at lowering wind resistance. Until speeds in excess of 50 m.p.h. are reached this power saving is very slight. A better reason for streamlining is to preserve traction at high speeds. The application of power to the rear wheels has a tendency to raise the sprung weight of the front of the vehicle. Visual proof of this is available by observing the upward leap of the front of a car at the beginning of a "jackrabbit" start. At high speeds the pressure of the stream of air flowing under the car has a distinct tendency to take up some of the weight of the car, thereby lessening the tractive contact with the road surface. Further, despite the power application tending to cause the rear end to dig in, at high speeds the velocity of the air streams passing the car tend to cause a suction with an upward pull that still further lowers the traction. At the speeds attained by racing cars this offers a serious problem and is solved only by the exaggerated beaver tail design of the body. Current body designs take care of these conditions for standard cars; but what of the car of the future, weighing 1500 lb., with the engine in the rear and traveling over specially designed highways at 100 m.p.h. and up?

This futuristic car will have a much lower center of gravity, simply because there is no enormous power and transmission equipment to prevent having it. But the power will be applied in the rear and there will be no half-ton of cast iron to help hold down the front end. All this points up the need for some close attention to body design but with fewer handicaps to accomplishing the desired ends. The writer offers one of his pet ideas herewith, consideration of which has afforded him much pleasant mental exercise. Let's design the front of the car deliberately to invite the air to enter a duct running under the body, placing in this duct the finned coils for the coolant. As the duct approaches the engine, which will be of the "pancake" type, we will change its shape from the wide and shallow to the circular. The fore end of our engine shaft will be extended and provided with a small gear both sides of which will be meshed with other gears driving propellers placed inside the rear or discharge ends of two branches of the duct. With these propellers, say 10 in. in diameter, and running at 7000 r.p.m., will anyone be surprised to find the car beginning to move before any power is applied to the rear wheels? Let no one think, however, that this is power for nothing because it is not. We are simply taking such advantage of certain necessary conditions that they become aids instead of hindrances. And before any of our "yeah-butter" friends become too loud in their condemnation of the idea, let them be informed that one of our enemies is now developing the idea successfully to drive a plane. The only change is that several impellers are placed in series, each running in the opposite direction from the adjacent one. The difference between the latter idea and the one proposed by the writer is the same as exists between two or more centrifugal pumps in series and in parallel.

Supercharging

The idea of supplying the combustion air to an internal-combustion engine at a constant pressure is fundamentally sound and potentially so valuable that it warrants complete understanding by the lay executive as well as by the petroleum technician. The writer finds, however, through discussion with many men, that this understanding does not exist; nor have refiners realized its significance to their plans for and operations of the future.

It has already been demonstrated by actual service operation that the power of the present standard engine can be increased something like 75 percent by increasing the weight of properly proportioned fuel charge in the cycle per unit of time. What the degree of this increase will be in the higher compression engine of tomorrow is impossible to predict but we have every reason to feel confident that the power per cubic inch of displacement can and will be doubled.

In view of the foregoing, the question: "If all this is true why has not something been done about it?" is pertinent and deserves an answer. The answer is very much the same as that given as the reason for our failure to develop many other ideas that were of obvious value; that is, we were not forced by necessity to do so. There has been, and still is, one mechanical difficulty that has retarded the development of a practicable supercharger. This problem is by no means minor and much remains to be done before it is solved but, as it has always been in the past, necessity will again perform her traditional function and a practicable device will develop.

Although the scope of this article does not include a detailed discussion of automotive apparatus it is pertinent to state briefly the reason for the prodigious increase in power per unit of displacement or, concomitantly, per unit of engine weight when the absolute pressure in the intake manifold is maintained constantly at a point above atmospheric pressure.

First, it must be realized that the only way offered to introduce gasoline into the conventional carburetted engine is by virtue of the suction effect caused by one of the two power-wasting strokes of a four-stroke-cycle (the conventional) carburetted engine. The strength of this suction basically controls the maintenance of a proper air-

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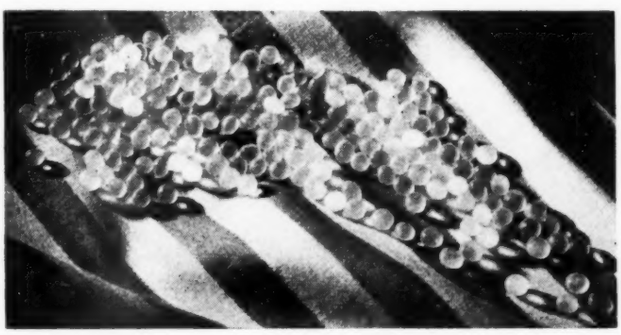

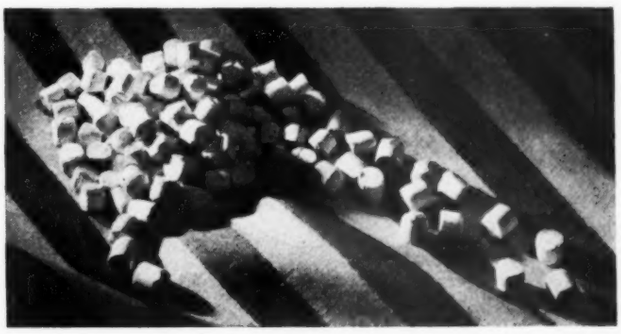

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fuel ratio in the charge, the intimacy of mixture of air and fuel and, because of these two conditions, has an all-important effect upon the fuel mileage. The strength of the suction effect, generally, is governed by the speed at which the engine is running and is lowered in the degree of throttle opening, by the turns in intake manifold and by the necessarily restricted area of valve ports.

From the foregoing it will be clear that with increase in load, the reduction in engine speed and/or wider throttle opening will reduce suction effect and, consequently, the velocity of air passing through the venturi tube of the carburetor, thereby lowering the tendency to pick up and atomize gasoline at the very time when more fuel is required. The only correction for this in the conventional carburetted engine has been handled by the carburetor which, under the increased power demand, supplies more gasoline through additional jets brought into the circuit. If the larger volume of air, which has been induced to pass through the venturi at high velocity by the low vacuum of the light load condition, effects anywhere near the optimo air-fuel ratio, what will happen to this theoretically correct ratio when the heavier load reduces the amount of air and the carburetor increases the flow of gasoline? The answer is simply that the air-fuel ratio suffers and the mixture entering the cylinders is richer than that required for best performance. Consideration of all this leads, inevitably, to the conviction that the carburetor designers have done a marvelous job but have at least reached the limit of practicality.

Weakness of Supercharger

Logical reasoning leads to the conclusion that to correct this deficiency in carburetion and to reach the goal of doubling the power of the engine requires only that air be supplied to the carburetor in greater volume than can be supplied by suction strokes of the engine itself and that this volume of air be controlled, not by speed of the engine, but by power demand. In a general way, and under present practice, the power demand is in inverse ratio to the speed, which creates the problem under discussion.

The problem is not difficult of solution in heavy vehicles that can absorb the weight and the cost of an independent drive motor for the supercharger. Several such units have been developed in the last five years and the recorded results of operation of some of them are sufficient to justify their initial cost and operating expense. The question might well be raised: "Why not copy airplane practice?", which makes almost universal use of supercharging. The answer is simple enough when it is considered that the airplane engine runs at a somewhat uniform speed when warmed up. Demands for increased power are met by changing propeller pitch. As engine speed is fairly constant supercharger drive can be taken directly from engine shaft and varying supercharging demands met by control of air volume.

The Next Corrective Measure

The carburetted internal-combustion engine in sizes used in ordinary auto-

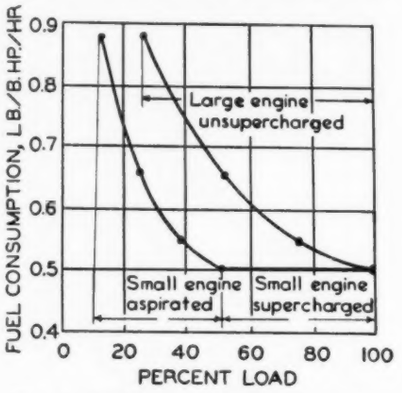

Fig. 1. Fuel economy of an unsupercharged engine and of a supercharged engine having one-half the displacement and the same maximum power

motive equipment is essentially a high-speed engine. With the idea of maintaining approximately right engine speeds and in so doing alleviating the condition just described, manufacturers have always provided selective gear sets as a part of the unit. Considerations of simplicity have held the number of gear ratios in passenger cars to three, but even with this limited number the average driver finds it to be too much trouble to use all of them. He starts his car in second gear, which offers a ratio designed for about 15 to 20 m.p.h. and when the clutch or some other part fails he blames the equipment for the failure; when he buys a new car insists that it have more cylinders in order that he can continue his foolishness without the annoyance of rough starting. It is interesting to the writer to let his mind go back to a time some 30 years ago when Overland came out with a cone friction drive. In theory this was a perfect answer, but the mechanical difficulties involved proved too great and the idea was abandoned.

Improvements in the selectivity characteristics of transmission gear sets have done something to encourage the driver to make more use of his lower gears and the automatic overdrive has helped, but only on the side of lesser importance, the high-speed condition. The real forward step has been the hydraulic transmission unit—call it fluid drive, hydromatic, or what have you. To build this to function as it should with the heavy duty imposed upon it by the heavy cars and multitudinous stops of today should cost at least five times that of the prices presently quoted. When, however, we have our car of the future, built something on the order of the ideas herein described, weighing perhaps 1000 lb. and traveling at 100 m.p.h. on non-stop highways, this hydraulic drive unit can be built and installed for a reasonable cost and can then function as it is intended to do — take completely out of the hands of the driver the adjustment of engine speed to car speed. Then we can truly and safely limit car speed by a governor without taking from the driver any of the power that he might need in an emergency in the lower speed range.

Not the least of the combined effects of these changed practices will be the substantial correction of the enormous friction losses now suffered. Because of the conditions and practices of the past and present—including human idiosyncrasies — as much as 50 percent of the actual output of our passenger cars is being wasted in friction.

Liquid Fuel Injection Engine

About a decade ago, necessity foaled another child for which a future was predicted at the time. The fact that time did not justify the predictions does not indicate that the child was deficient; rather that other children came along better equipped to perform the required duties. One of the penalties we have been paying for many years for our enormous volume production of automotive equipment is the lack of coöperative design. The concrete result in the case in point is that we have been making our motor gasoline to specifications made necessary by carburetor design only. The carburetor designer in turn was aiming primarily at atomizing and metering the fuel to the engine without necessarily giving any particular consideration to changes that were being made in motor design from time to time. When the carburetor people demanded of petroleum refiners a fuel of lesser density (high A.P.I gravity) in order that they could atomize it more completely, a new trouble arose. The conventional vacuum tank method of transferring the fuel required by the engine from tank to carburetor began giving trouble from vapor lock with the light gasoline. The mechanical fuel pump was then brought out and was proclaimed as the answer to these troubles. This turned out to be as far from the actual fact as devices called revolutionary usually are. It was

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The conduit box is of cast-iron construction, bolted to the motor frame with four bolts. The joint between the box and the motor frame is tightly sealed.

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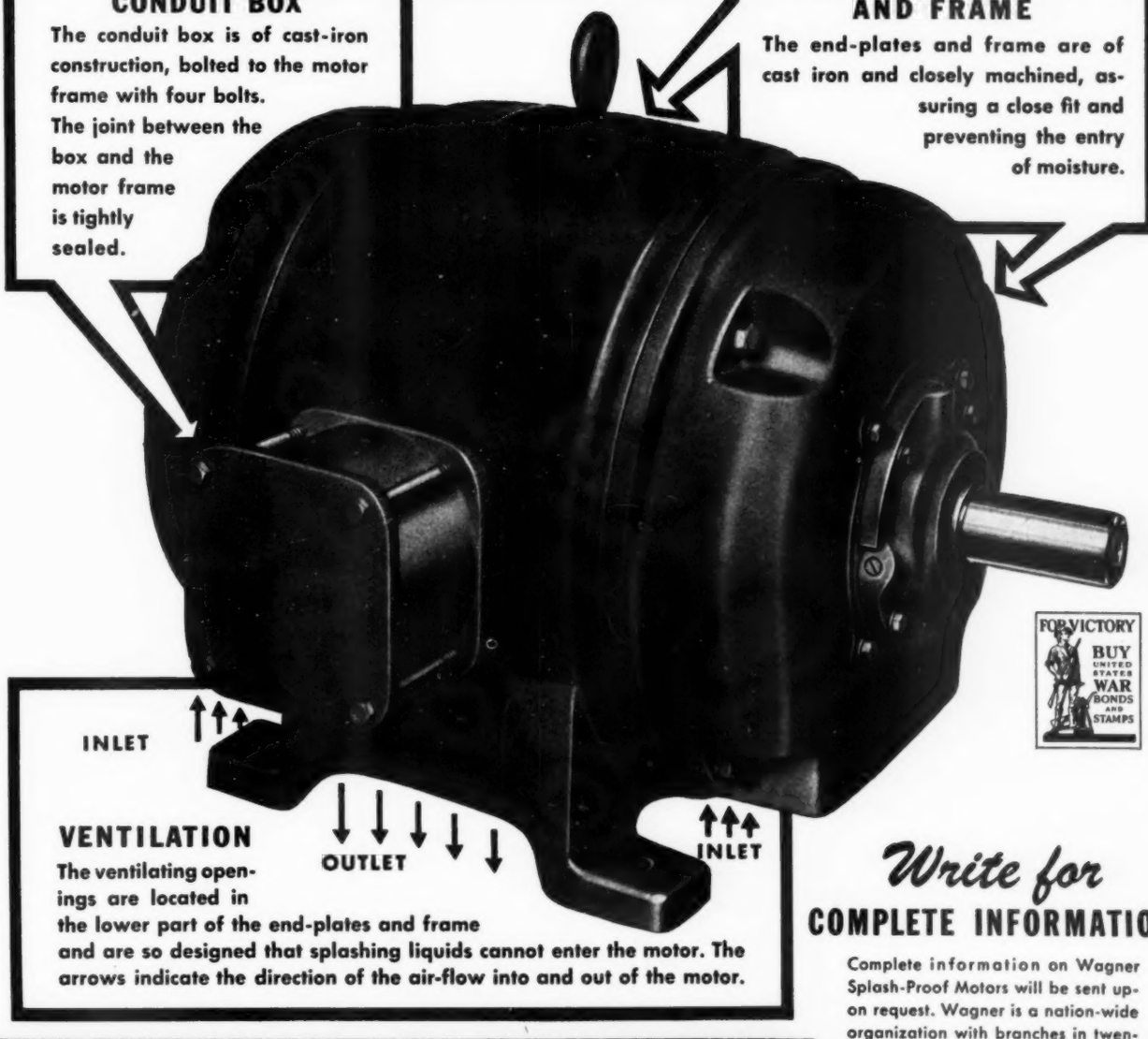
The end-plates and frame are of cast iron and closely machined, assuring a close fit and preventing the entry of moisture.



VENTILATION

The ventilating openings are located in the lower part of the end-plates and frame and are so designed that splashing liquids cannot enter the motor. The arrows indicate the direction of the air-flow into and out of the motor.

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simply another forward step but the troubles from vapor lock persisted. Whenever the temperature under the hood became high enough, either from outside sources and/or the heat radiating from the motor, to overcome the cooling effect of the vaporization of the gasoline by the carburetor, not enough gasoline reached the cylinders and the engine stopped. The carburetor had been "perfected" but was not "perfect," and therefore the fuel made to the carburetor specification may have been perfected but was not perfect.

Thus came the conception of the idea of providing the engine with its fuel in liquid form, with the heat of compression plus the stored heat in the engine helping to provide the heat for partial vaporization of the gasoline. The major portion of the atomizing was to be handled by the restricted orifices of the atomizing nozzles. This idea was, of course, simply that of adapting a part of the Diesel cycle principle to the gasoline engine, which operates on the Otto cycle principle. More than ten years ago, according to a trade publication of the time, an engine of this type was developed and given a thorough service test in aircraft. According to the magazine article, the trial was made in a 525 hp. Hornet engine and the major objective of the test was to use a fuel less inflammable than gasoline. The fuel used was said to be produced by the hydrogenation process with particular attention having been given to high flash qualities and the stock had a clear octane number of 82.6. It was further indicated that fuels produced by the hydrogenation process had inherent anti-knock values. The article was very interesting but closed with the significant statement: "The engine will not be offered to the trade for general use at this time." The reader may place his own interpretation upon this.

Closer Coordination in Design

In recent years there has been closer coöperation between accessory manufacturers and the automotive designers. The result has been that our fuels are now made more to actual thermodynamic requirements of the engine and the carburetor people seem to have been able to handle such fuels satisfactorily. But, as has hereinbefore been stated, the conventional Otto-cycle carburetted engine, in itself, has at last reached about the pinnacle of its possibilities, as it is no better as a power generator than it is as an air pump. Supercharging is the key to the door opening into the increase in power per unit of weight or of displacement.

It will be obvious to a mechanical man that the satisfactory operation and efficiency of a solid injection internal-combustion engine of either the Otto or Diesel cycle depend very largely upon the mechanical accuracy of the cam action that controls the fuel injection. This accuracy is not particularly difficult to attain but there is a definite limit to the shaft speed at which it can be maintained. This factor has retarded the development of such a power unit for any except a relatively heavy piece of equipment. It will doubtless have a certain field of future application in heavy vehicles. A satisfactory fuel for it can have an I.B.P. of as high as 300°F., and an E.B.P. of up to 550°F.

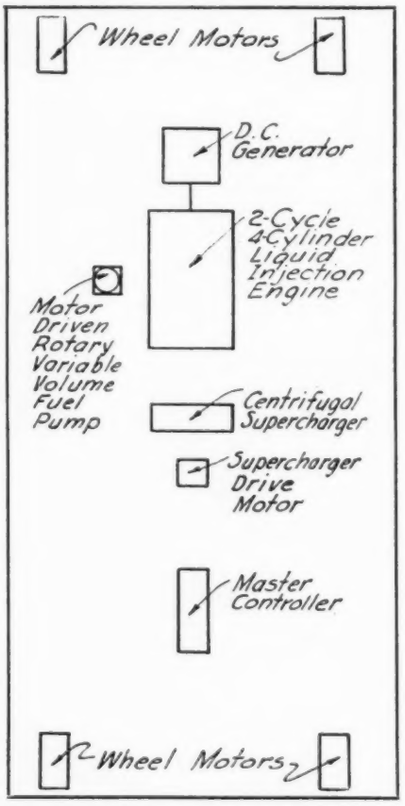

Fig. 2. Schematic drawing showing how electrical transmission equipment might be applied to a truck or bus powered by a liquid injection engine

Summing up the case for the future of this engine, it is entirely reasonable to expect that it will fit well into the transportation picture because of its ability to use this medium distillate that might otherwise be without profitable market. Tailoring of petroleum products to order by synthesis might need just such a market to make it a complete commercial success.

Application of supercharging to this type of engine will be of great advantage, not only for the reasons already stated, but for the further fact that it can then be built and operated as a 2-cycle motor with the head of supercharging air available for scavenging as in a 2-cycle Diesel motor. In fact, the engine would be of Diesel type except that the charge would be electrically ignited and the compression somewhat lower than the true Diesel. Some sacrifice of power would probably be made to avoid the knocking tendencies of the distillate. Do not erase this whole idea from your picture. It is pregnant with possibilities.

Liquid Injection Engine

The utility of the liquid injection engine depends largely upon maintenance of accuracy of the cam action for opening valves and spring action for closing them and this accuracy is much more important in a two-stroke-cycle motor than in a four-cycle. The stroke of the cams and the strength of the springs can be designed for a given speed of engine and any wide variance in speed tends to defeat the accuracy. It is of major importance, therefore, that the speed range be narrow and relatively low. It must be remembered that cam action must operate valves, not only in conjunction with piston position, but is also called upon to regulate the *amount* of fuel being supplied to each cylinder; and this amount is only a fraction of the volume of the vaporous air-gasoline mixture that would be passing through the intake valves of the carburetted engine under equal power demand. Because of this the fuel regulatory apparatus must be designed, manufactured, and maintained with greater care than in the motor of the usual engine. This is the penalty that must be paid in order to overcome the fundamental weakness of carburetion.

The liquid injection engine, being essentially a low-speed motor, will necessarily be a relatively heavy unit that will, as has been noted, tie it to a heavy-duty vehicle. This in turn so increases the duty on whatever type of transmission unit is used that additional consideration of that equipment is warranted. The hydraulic transmission is far from perfected for all degrees of heavy duty and, as it has certain inherent characteristics that at present seem to indicate that its utility is likely to be somewhat limited in the low-speed, heavy-duty field, it will be well to survey the idea of using electrical equipment for the purpose. There is nothing new about the basic principle; in fact, it may well be said that, had not the idea been developed, the present Diesel-engine-driven streamline trains might not have been so successful.

Fig. 2 is intended to show how the idea can be applied to a truck or bus. The sketch is entirely schematic and should be so treated. The writer recommends that each reader run his own "cerebral distillation" on the idea and see what he gets out of it.

(Continued on Page 87)

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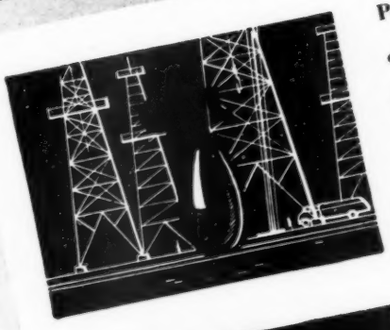
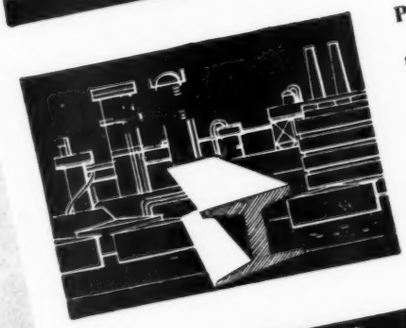


Petreco Electric Dehydrating, in closed, vapor-tight, A.P.I.-specification vessels, prevents evaporation losses, thereby conserving volume and retaining true gravities.



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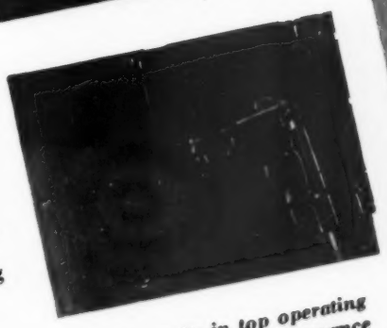

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Representatives in all principal fields and refining centers

(Continued from Page 84)

Probable Weight of Unit

To say that the proposed unit is, necessarily, a heavy assembly without some discussion is bound to be misleading. The electrical equipment will, of course, add to the total weight but hardly in the degree that some might think. Balancing off the saving in weight of a 2-cycle, 4-cylinder motor against the added weight of the fuel control devices, it is probably safe to conclude that the engine itself would not weigh more than 60 percent of the weight of a conventional 4-cycle, 6-cylinder, carburetted engine of equal power. The generator and motors will weigh more than the conventional selective gear transmission set and friction clutch but the differential will not be greater than the weight saved in the engine itself. The expression "relatively heavy," therefore, as used earlier in connection with the liquid-injection unit, relates to the weight of the carburetted engine of the future and not to the present motor of equal power.

Advantages of Proposed Plan

The plan, as shown, represents only the cerebral distillation of one man and he claims for it only that it represents an idea that is fundamentally sound but which is bound to be saturated with "bugs," many of which can be eliminated by consideration given it by others better informed on various phases of the proposition than he.

One of the objectives of the plan is to make profitable use of certain petroleum fractions that would require rather costly processing to make them suitable for the high-compression carburetted engine. This is a logical responsibility of the petroleum man as much as it is of the automotive designer. We cannot justifiably complain that our customers are causing our manufacturing costs to rise beyond reason unless we are prepared to suggest methods of using petroleum products that do not demand these costly manufacturing processes.

Let's take the driver's seat on this unit and see how we work it. We will start the engine in the usual way except that the starting switch is the first position on the master controller and serves also to start the fuel pump in low volume position and the supercharger at low speed. The next position is the one from which we will operate. As the engine warms up and we are ready to shove off, we advance our electrical throttle slightly, which, working through rheostats, energizes fields of all traction motors and the supercharger drive. Required additional volume of fuel will be supplied automatically by a solenoid connected to the variable volume device on the fuel pump. The solenoid and fuel pump motor fields are synchronized through the master controller. The driving control will be by tachometer with the proper speed range plainly indicated thereon. Automatic maintenance of proper relationship between engine speed and vehicle speed would be the relatively simple matter of a centrifugal governor attached to camshaft, which would increase or decrease the amount of fuel fed to the cylinders as the engine revolutions vary from the rate called for by throttle position. Varying the excitation of the generator field coils offers an infinite power range within the capacity of the engine. Electrical transmission, generally, simply provides a variety of "gear ratios."

The traction motors can as well be made integral with each wheel with obvious advantages. No special difficulty should be encountered with front wheels, which must be pivoted for steering. Extra flexibility in conducting cables can be provided. The traction motors can also serve an important secondary function by acting as dynamic brakes. Reversed, they become generators and the hold-back thus developed is like that of driving down hill in a lower gear except that the braking effect is under closer control in just the same way and for just the same reason that the power driving is under closer control by electrical transmission than it could possibly be with any form of mechanical transmission. Heat generated by the dynamic braking could readily be dissipated by metal grills placed in the air stream.

The Rotary Engine

There is no denying the importance of the part played by the rotary, air-cooled engine in the development of aviation, nor has its value been confined to aerial and fast-traveling vehicles. It is no longer a matter of military secrecy that rotary engines are considered of value in propelling very heavy and relatively slow moving combat vehicles. The problem of adequate cooling is probably solved by using a propeller that performs the double function of providing the air stream for cooling and, in doing so, actually develops some propulsive effort.

To use a rotary engine in the light and high-speed cars of day after tomorrow, the writer suggests that we enlarge upon the idea previously mentioned of using one or more air tunnels. The engine itself need not be large, for a light car and its drive could be divided into, say, two series-multiple sets of propellers placed at forward ends of air tunnels. Perhaps some of our readers who are informed in this branch of science will take over the task of telling just how much, or how little, sense there might be in this idea. The thought is at least intriguing if for no reason other than that it would certainly add to the life of our highways if they could be relieved of traction wear, which is many times the rolling frictional wear.

What About the Steam Engine?

The idea of using a steam engine for automotive transportation has been advanced many times and has had some degree of successful development. The reasons for its failure to receive more general application have not been those commonly believed. There has never been anything particularly wrong with the idea that was not correctable. In fact, steam offers the same degree of flexibility of control as the electrical transmission. The principal reason for its failure to hold its own has been the ingenuity of the automotive designer in keeping up with the demands for a light, simple transportation unit with sufficient flexibility of control, by making use of the familiar internal-combustion engine and selective gear ratio transmission.

The liquid injection engine with electrical transmission is likely to find some competition from the steam prime mover in the future; not so much because of control features but for two other good reasons, one of which should be thoroughly understood and analyzed by oil refiners. It has always been true that the success of any type of power machine has been, in a considerable degree, dependent upon availability and cost of its fuel. In fact, this very thing brought out the Diesel engine for mobile units. Throughout the present discussion has been the thought that the ultimate in a light and mobile internal-combustion engine depended upon a fuel that was more or less special and that its availability in large quantities entailed costly processing because, as the percentage recovered from a unit quantity of crude petroleum increases, so does the processing cost rise in more-than-proportionate degree. It does not require a doctorate in economics to realize that this sets up an ideal condition for the steam plant. It should be kept in mind in making this analysis that the synthesis of high octane gasoline, according to our present knowledge, leaves no residual or by-product stocks suitable for use in a compression ignition (Diesel) engine.

Another point on the credit side of the steam drive account is overload capacity. Although the overload capacity of any type of internal-combustion engine is very limited, the steam engine can be loaded considerably beyond its rated capacity. It is assumed that the steam generator and condenser would be able to handle their parts of the overload.

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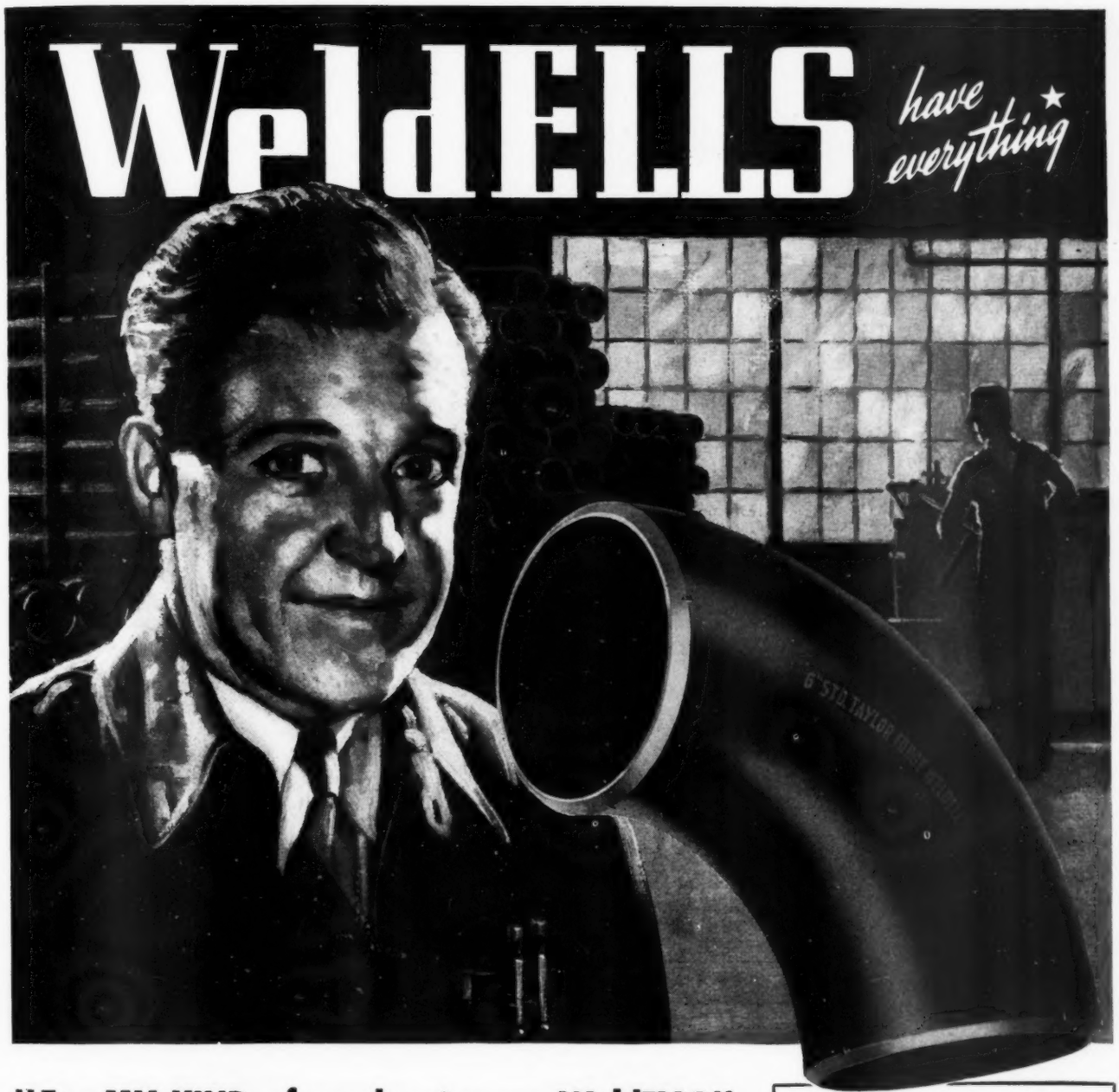

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Types of Steam Engine

Any type of contra-flow steam engine is out of consideration because of initial condensation and multiplicity of parts. The uni-flow engine, however, has several points in its favor when compared with a steam turbine. It is simple, efficient, relatively light per unit of power, and can handle steam of fairly elevated pressures and temperatures. The pressure limitation is only because of concomitant temperature and the lubrication difficulties introduced thereby. A detailed discussion of uni-flow versus contra-flow steam engines is not warranted in this article and it should suffice simply to say that the uni-flow, far from being a new idea, has been used with marked success for many years in Europe. Some 30 years ago an endeavor was made by at least two old line engine manufacturers in this country to popularize the unit for power generation in medium sizes. The endeavor was not completely successful for reasons that reflected credit rather than discredit upon the design. It is pertinent to point out also that the last steam-driven automobile marketed in this country had this type of engine. The uni-flow engine is very efficient when operated condensing, which would be necessary in a mobile unit for obvious reasons. Its efficiency is better than a turbine when under low vacuum, which condition would prevail at low engine or car speed.

The Steam Turbine

The chief advantages of the turbine are its high speed and consequent light weight and the fact that, as it does not require lubrication other than bearings, steam of very high temperature can be used. The use of the high speeds and temperatures are likely to be restricted for passenger car use by the natural fear of riding along the highway with some machinery underneath one that was turning over, say, 5000 times a minute and using for power a vapor of 1000 or more lb. per sq. in. pressure and 700°F. or higher temperature.

The Gas Turbine

The idea of using gases of combustion directly upon the blades of a turbine rotor has intrigued engineers for years. The objective is very attractive, amounting perhaps to a doubling of efficiency; but obstacles have seemed insurmountable. To find an alloy for the blades able to withstand the temperatures involved has not thus far been done. We do know, however, that such a machine has had some degree of success in Europe and we are justified in a feeling that we can do as well, or better.

Coke

There now exists a new and heretofore unconceived demand for a petroleum by-product, the significance and magnitude of which is not generally realized. It is, in fact, a distinct reversal of past relationship between supply and demand. One of the worries connected with cracking has been to find some means of disposing of the residual coke. The market for it in briqueted form to use as a fuel has been negligible for a simple economic reason. In the area of petroleum refining plants there is certainly no demand for a solid fuel. Processing and transportation costs remove it as a competitor of coal in other areas. Advances in cracking science have minimized the percentage of coke but also emphasized the advantage of a straight-run distillate (gas oil) as a charge stock.

Now, however, we are faced with a condition that is likely to reverse all the foregoing. The production of 2,000,000,000 lb. of aluminum is expected in 1943 from plants already built or under construction. The method of refining the base ore, bauxite, involves electrolytic cells both poles of which are composed of practically pure carbon and this carbon is consumed at a rate of ¾ lb. for each pound of aluminum produced. The carbon necessary, therefore, is 750,000 tons. Petroleum coke is the material presently considered to meet standards of purity and from which this carbon is to be manufactured. In light of this it appears that a petroleum refiner has profit potentialities in coke.

Butadiene

If all the words that have been uttered by radio commentators and others of perhaps still less accurate information on this subject could be polymerized into anything approximating a rubber compound, there would be no rubber problem. The trouble would be that the words would not produce a compound that would resist the decomposing effect of sun and air. A technical man cannot hope to compete with these men of many words but he feels that a little ventilation of the subject will be of interest.

The dissension seems to have centered around the question of making butadiene from ethyl (grain) alcohol or from a petroleum distillate and/or gas. The situation will be much clarified if it is viewed from two distinct time angles—now and the future.

The present need for rubber is something that admits of no consideration from any angle except that of providing the required amount of latex in the shortest possible time without prejudice to other and vital military needs. All arguments over the use of critical materials for the rubber program versus their use for other military purposes do not add one ton of steel to the total available for all purposes. No person could possibly make a division of the materials between the two interests that would be satisfactory to all. It would seem, therefore, that it would be just simple, sound sense to accept the judgment of a limited group of fair minded and unprejudiced men, stop this senseless bickering, name calling, and wise cracking and go on down the line as laid out but be prepared to change the ratio of apportionment of steel from time to time as changed military and other circumstances indicate.

The time element is the justification for producing butadiene from petroleum. The oil industry has the raw material and can convert it into usable form in a minimum of time and with the use of a minimum amount of critical materials—but no amount of "deploring the necessity" will supply these needed materials. A further reason is that certain by-products of the petroleum process are a source of much needed explosives.

Of the many processes considered for production of butadiene from petroleum there are at least two that have been thoroughly worked out and found to be practicable from every angle. Certainly no valuable time should be spent now in conducting research to find others. Improvements in existing processes will follow as a perfectly natural course. Selection between catalytic dehydrogenation of normal butane or the Jersey process can well be made entirely a matter of availability of charge stock. When this discussion has passed on into a more technical phase this point will receive more complete dissection.

On the other side of the picture it will require some highly prejudiced vision to find any justification for the continued and permanent use of a natural resource that is irreplaceable for the manufacture of a constantly expendable material when another source of raw material is available that is replaced each year by nature's bounty.

Other Products

There is no thought in the whole analysis presented in this series of articles that the potential field of petroleum products has anywhere nearly been covered. Progress in petroleum synthesis is so rapid that a chart made with the idea of being complete would not be finished before the research men would be hanging around with additional products.

In forthcoming articles the writer will endeavor to bring out, chiefly by graphic means, processes that are currently considered the ranking ones for production of the stocks whose utilization has been pointed out here.

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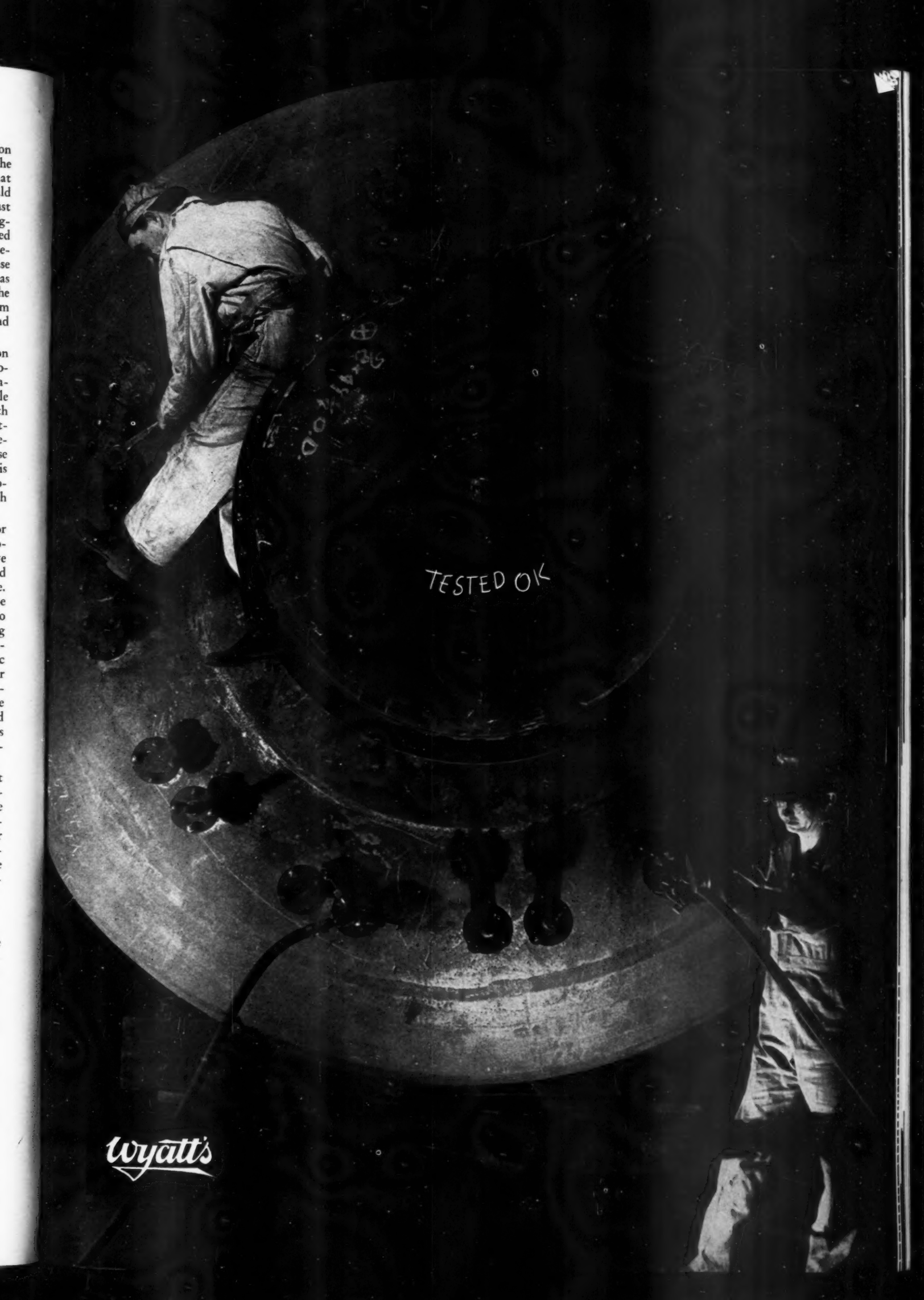
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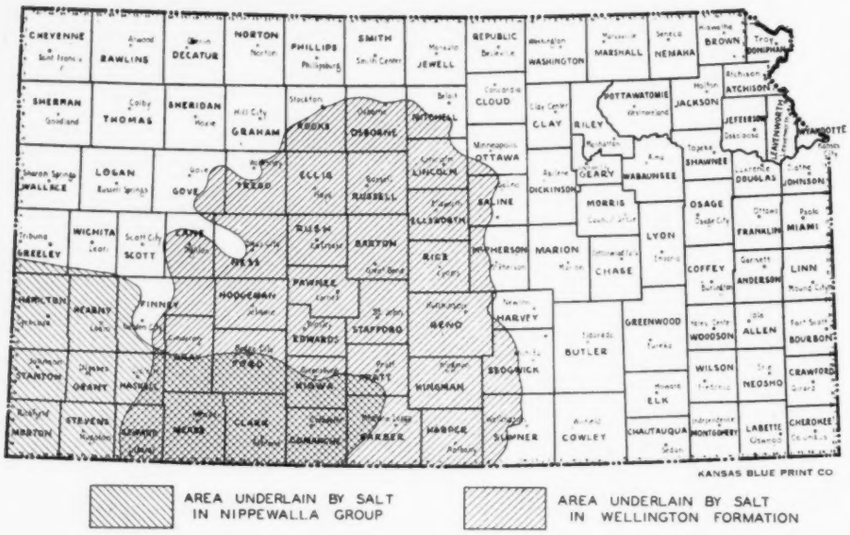

Fig. 1. Base map of the state of Kansas showing areal distribution of Permian salt beds of the Nippewalla and Wellington formations

(Geologic data courtesy Kansas Geological Survey, Lawrence, Kansas)

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Electrical Logging Through Thick Salt Zones

☆ Replacing lower part of column of salt-laden drilling fluid with fresh-water mud effective in Central Kansas wells

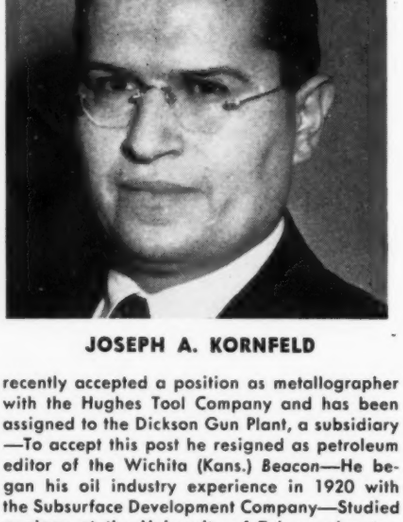
by Joseph A. Kornfeld

AN INCREASE in the use of electrical logging methods for wells in the Central Kansas area has recently followed the widespread application of a new field method for overcoming the detrimental effect on electrical surveying in salt-laden rotary drilling mud resulting from contact with thick salt beds in the course of shallow drilling.

The result of continuous circulation of rotary drilling fluid through the shallower saline beds was to minimize, and in some cases destroy, the spontaneous-potential phenomenon when an electrical logging survey was run. The problem thus created complicated interpretations regarding where the porous zones might occur.

The effect of attempting to run electrical surveys through a solid column of uniformly-high content of chlorides and its nullifying results for determination of porous zones, had discouraged the use of electrical surveying of wells drilled in certain parts of western Kansas overlain by thick salt deposits.

Solution to the problem lay in improvising some method of improving the spontaneous-potential electrical curve that would show more accurately the vertical position of the porous zones and give a better relative value of the porosity of those breaks than had been obtainable when salt-laden mud was present in the rotary drill hole to cause a considerable drop in the resistivity of the drilling fluid.



JOSEPH A. KORNFELD

recently accepted a position as metallographer with the Hughes Tool Company and has been assigned to the Dickson Gun Plant, a subsidiary —To accept this post he resigned as petroleum editor of the Wichita (Kans.) *Beacon*—He began his oil industry experience in 1920 with the Subsurface Development Company—Studied geology at the University of Tulsa and petroleum engineering at the University of Oklahoma from 1926 to 1930—Leaving school he entered the employ of Skelly Oil Company as assistant editor of Skelly News at Tulsa, Oklahoma, leaving that firm the following year for similar duties with Cities Service Oil Company—In 1934, he went to the Gulf Coast to edit the oil page of *The Houston (Texas) Post*, which position he held until August, 1935, when he became geologist and engineer for Barnett Petroleum Corporation of Houston, Texas—He resigned in 1937 to edit the oil news on the *Wichita Beacon* and to enter consulting practice.

Experimental work conducted since April, 1940, by a leading well surveying corporation indicated that a small increase in the electrical resistivity of the drilling fluid resulted in an improvement of the spontaneous-potental electrical surveying curves.

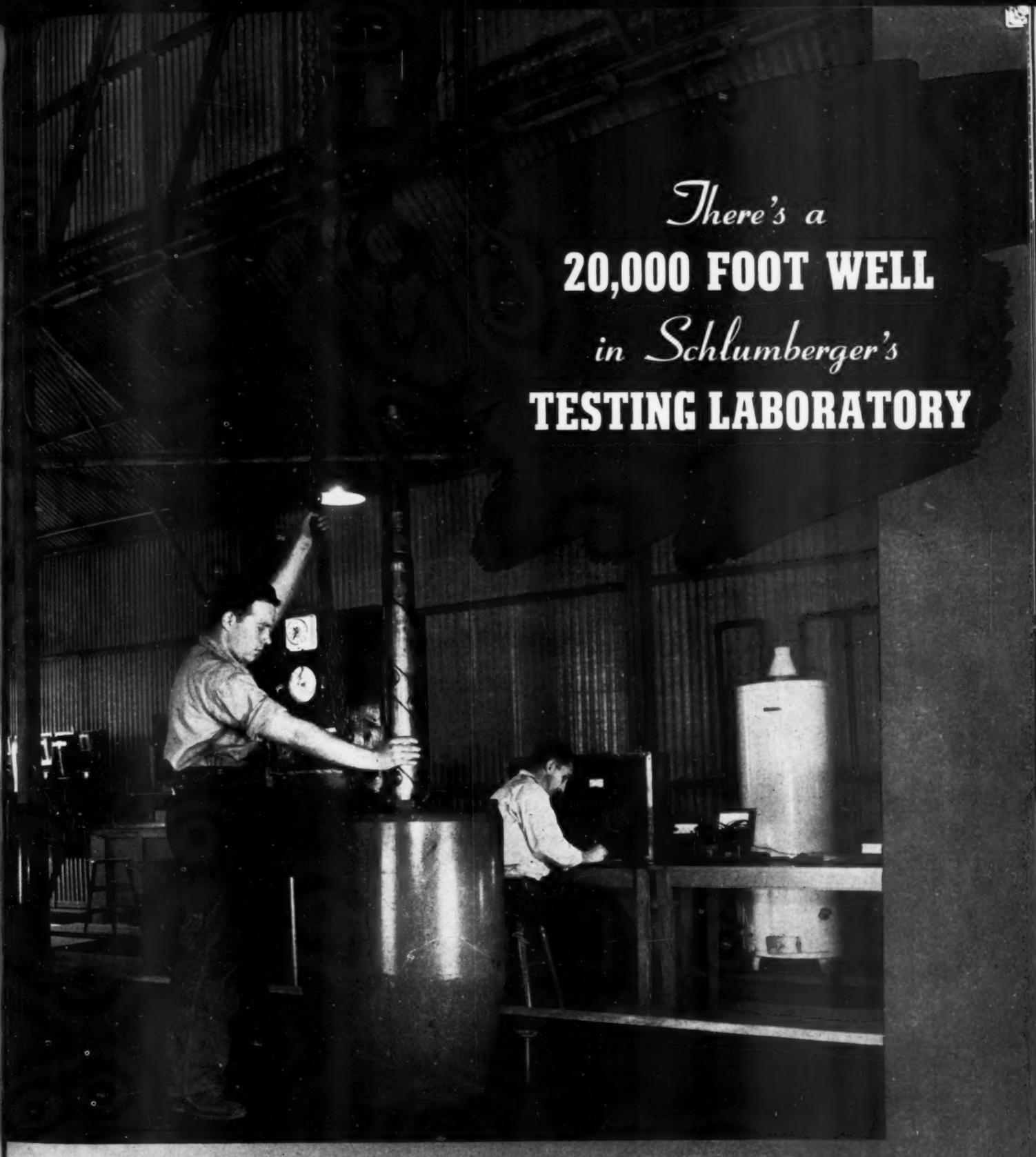
In commercial practice, the answer was found by replacing the lower portion of the column of salt-laden drilling fluid by pumping fresh-water mud through the drill-stem from the bottom of the hole and by using a greater recording range in the recording graph.

Permian Salt Deposits

Excessive contamination of drilling mud with chlorides results from continuous circulation opposite drilled sections of thick salt beds in the Permian system in the course of drilling. These are found in Kansas in three formations of the Permian (in ascending geologic order): Nippewalla group, Ninnescah shale, and Wellington formation.

The most important of these salt deposits both in areal extent and in thicknesses is found in the Wellington formation, where saline beds underlie an area extending for 150 miles from east to west and 180 miles from north to south, to within 40 miles of the Nebraska state boundary line. A maximum thickness of 300 ft. is attained in Ellis and Russell counties.

Salt beds found in the Ninnescah shale are of minor geologic importance



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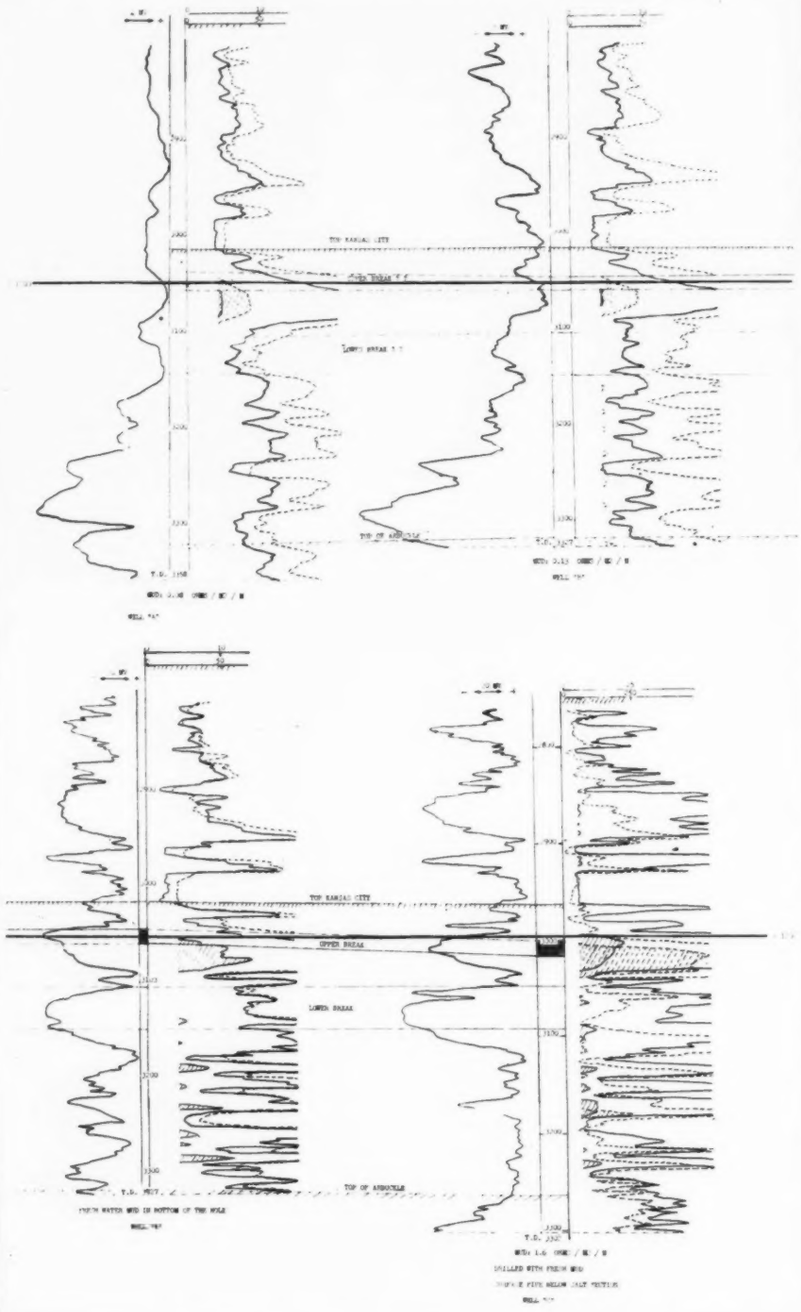
and of extremely limited areal extent; they attain a maximum thickness of 100 ft. in Pratt County.

The Ninnescah shale is overlain by the Stone Corral anhydrite-dolomite series, which are in turn covered by the Nippewalla group. The Flower Pot shale, uppermost member of this group, carries salt throughout an area in southwestern Kansas extending for 175 miles from east to west and for nearly 100 miles from north to south. Thicknesses of as much as 80 ft. have been logged in a test well in Hamilton County near the Colorado state line.

Fig. 2. Comparison of four electrical logging surveys of three oil wells in the Trapp pool, Russell County, Kansas, which proves the value of spotting fresh water rotary mud in the lower 800 ft. of drilled section to overcome the detrimental effects of salt-laden mud on electrical well-logging surveys. Well "A" shows a typical electrical log of the field. Well "B" was surveyed twice, first with salt-laden mud (upper-right survey), secondly with fresh-water mud (lower-left survey) with favorable results. A third well "C" was surveyed electrically 1½ years later at a location one-fourth mile from well "B" and with fresh-water mud after the drilling crews set surface pipe below the trouble-giving salt section. Results compare favorably with the fresh-water mud survey of well "B"



Electro-Chemical Theory

A brief review of the fundamental theories and the phenomena surrounding electro-chemical properties of drilling fluids is necessary for a proper understanding of the importance of the use of a salt-free mud for surveying porous zones opposite the desired productive formation objectives.

Two principal effects are recognized in interpretations of the spontaneous-potential curves: (a) Electro-filtration, and (b) Electro-chemical contact effect.

The (a) effect, that of electro-filtration, represents the opposite of the well-known physical phenomenon of osmosis, a theory first formulated in 1859 by Helmholtz. It is the phenomenon of the electrical potential arising from the filtration of a fluid through a porous diaphragm (in this case, the mud filtrating from the hole to the formation through the mud cake). Its electrical sign is always negative and its value is proportional linearly to the resistivity of the mud. When the resistivity of the mud is small, the electro-filtration effect is small. Recognizing the fact that as the concentration of chlorides rises, the electrical resistivity drops (see chart), it is easy to understand why the electro-filtration effect is small when the concentration of chlorides is high. This effect relates directly to the permeability of the formation, or fluids in motion.

The (b) effect is the electro-chemical contact effect inherent between two fluids. It is the phenomenon studied by Nernsdt and first described in 1889. It assumes the existence of a certain porosity but does not relate to the permeability or fluids in motion described in the (a) effect. The (b) effect is proportional to the Napierian base log of the ratio of the concentration of chlorides of the two fluids in contact. Its electrical sign is either positive or negative, depending upon the character of the concentration. This is demonstrated mathematically as follows:

Where: $C_1 > C_2$

$$\frac{C_1}{C_2} > 1$$

$$\therefore \log \frac{C_1}{C_2} > 0 \quad \text{or positive.}$$

Where: $C_1 < C_2$

$$\frac{C_1}{C_2} < 1$$

$$\therefore \log \frac{C_1}{C_2} < 0 \quad \text{or negative.}$$

Thus, if the drilling mud is less saline at the outset than the formation fluid, this effect is also negative; it adds to the already-negative status of the

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(a) or electro-filtration effect. If, however, the salinity of the drilling mud is of a higher concentration than that of the formation fluids, the (b) or electrochemical contact effect will be positive and counteract (a). In some cases, the magnitude of the positive effect in (b) might become great enough not only to cancel (a), but result in a positive, abnormal anomaly potential. The effect (a) is small because the salinity of the mud is high; in this case, the resistance is low.

Experimental Background

Field representatives of a leading well surveying corporation in Kansas, faced with interpretation problems of the spontaneous-potential curve in surveys run in wells drilled in the areas underlain by salt, encouraged experimentation by studying the effect of mud reconditioning to obtain reliable electrical curves. Accordingly, in cooperation with one leading integrated company in Wichita, experimental studies were made in the field in the Coralena pool of Russell County, principally of the geologic section opposite the Lansing-Kansas City lime series, one of the producing formations. (The Coralena pool has since been combined by the state corporation commission with the Trapp pool.) The average thickness of the Wellington salt beds in this locality is approximately 280 ft. The electrical resistivity of the rotary drilling fluid is 0.1 ohms, m^2/m, or less.

Oil production is obtained in this pool from porous limestone zones popularly called the 30-ft. break, the 55-ft. break, the 80-ft. break, the 120-ft. break, and the 150-ft. break. These zones are so-called from their respective vertical interval from the top of the Lansing-Kansas City lime series. For electrical studies, however, the 30-ft. and 55-ft. breaks have been combined, and the 80-ft. and 120-ft. breaks are considered together.

The graphic electrical effects are clearly demonstrated by the comparisons shown on the electrical surveying logs of three wells in the Trapp pool. (See Fig. 2.) Well "A" is shown at the extreme left of the chart to illustrate a typical electrical log usually obtained from this field.

Well "B" was surveyed twice during April, 1940. The first survey was the conventional run made with the salt-laden drilling mud in the entire section of the drill-hole. The second survey was run one day later in the same well after a quantity of fresh-water mud, of 5-ohm resistivity, was spotted through the drill-stem and circulated. Actually, the fresh-water mud was composed of mud and chopped ice designed for the purpose of running differential temperature surveys rather than for the primary objective of improvement of the spontaneous-potential curve.

The chart, which shows the two surveys of well "B," proves that whereas the second survey (fresh-water mud) was recorded with a resistance range of 20 mv., 10 miles greater than the 2 mv. customary range used in the first survey, the second survey reflected more detail in the spontaneous-potential curve.

Likewise the resistivity curve in the second survey (using fresh-water mud) showed not only greater electrical values but much sharper detail than those found in the first survey, which employed mud of high salinity due to contamination while drilling opposite the higher salt beds.

One and a half years later, well "C" was surveyed, two locations from well "B." For experimental purposes, the surface pipe was set below the salt section and landed at a depth of 1566 ft. Moreover, the drilling mud was changed to fresh-water mud after the pipe was set. The resistivity of the fresh rotary mud was 1.6 ohms, m^2/m. Comparison of the spontaneous-potential curve of well "C" with the fresh-water mud survey of well "B" shows very close correlation, proving the value of using a higher resistance mud for improvement of the spontaneous-potential curve.

Additional improvements noted from the use of the fresh mud in surveying the producing section include the straightening-out of the reference base line of the spontaneous-potential curve, a condition clearly shown in well "C." Another feature was the resulting transfer of positive spontaneous-potential anomalies to negative electrical positions.

The interpretation of these curves and fluid contacts remains a complex problem. Use of additional field data coupled with current research will eventually offer a more complete understanding of the problem.

Field Practice

Field practice currently employed in the improvement of the (a) or electro-filtration effect of the rotary drilling mud to obtain sharper, more diagnostic electrical logging surveys may be described as follows:

When drilling operations are completed in a test well, either when the last formation objective has been reached, or when the contractor has finished his depth obligation, arrangements are made for an electrical survey. Fresh rotary mud is prepared in a separate, clean pit and pumped into the drill-stem with the mud pumps at the rig. It is prepared heavier than the salt-laden fluid to prevent mixture; use of a lighter gravity mud would cause reverse circulation and defeat the purpose of the project.

The fresh mud is spotted from the bottom of the newly completed well bore and displacement is brought about by pump pressure. The amount of fresh mud spotted through the drill-stem is determined so as to fill the lower 800 ft. of the bore-hole; this should reach up through the Topeka limestone of the Pennsylvanian. Operators contemplating surveys of this kind find it more economical to dig an extra pit at the beginning of drilling in addition to the regular mud pits. Some drillers have been reluctant to run two kinds of drilling muds in the same hole due to an unfounded assumption that it would cause caving, but so far field experience shows little trouble from admixture of muds of two different gravities.

☆ ☆ ☆

Refinery Directives Now Issued by Cumming

Authority to issue operating directives to petroleum refiners has been delegated by Deputy Petroleum Administrator Ralph K. Davies to E. D. Cumming, PAW's Director of Refining, Davies has announced.

The delegation is expected to result in more expeditious operation since any appeal for exception to refinery directives will be handled promptly and in the first instance by the Refining Director.

Text of the delegation follows:

"Pursuant to the authority contained in Section 7 of Executive Order 9276 as Amended by Executive Order 9319, you are hereby authorized to take the following action in your own name as Director of Refining of the Petroleum Administration for War:

"You may issue to the refiners in the various districts, by telegrams or otherwise, necessary operating directives relating to the extent and character of refinery operations, including without limitation directives as to the permissive amounts of crude to be run and products to be made therefrom under Plan 15 and such other plans, orders, recommendations, directives, or policy determinations as may from time to time be issued by the Petroleum Administration for War."

is a stronger bond than fear!

Why do the men in the armed forces of the United Nations fight with such fervor and ferocity? Why did these nations hold together and work together in spite of early defeats due to unpreparedness?

The answer is that Liberty is a stronger bond than fear. Its authority springs from the free consent of the governed, while the authority of the Axis ideology is the will of gangmen who use their usurped power to enslave the masses.

Free men have always been better fighters; they are better fighters in this war. They go into battle with an undefeatable determination to save the one possession human beings desire above all others—liberty. The initiative and resourcefulness that liberty engenders in free men is manifested in the invention, quick adaptability to new requirements, and astounding production of free enterprise here in America.

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Control of Pipe-Line Corrosion

☆ **Simplified discussion of the corrosion problem and practicable methods developed to minimize loss from this cause**

by G. R. Olson

Corrosion Engineer, United Gas Pipe Line Company

DEVELOPMENT of corrosion control methods, particularly cathodic protection, is now well past the laboratory and experimental stage. Our company has been pioneering this work and for some time has been applying the latest principles in a practical way on a relatively large scale. Much work remains to be done in perfecting designs and improving practicable installation and maintenance methods. The rate of future progress will depend largely on the ability of operators and engineers to coöperate in coördinating theoretical ideas with practical field conditions in order to realize maximum economy in our corrosion control program.

It is hoped that this non-technical discussion will help all employees, particularly those who are not specializing on corrosion control, to obtain a clear picture of the purpose, scope, and limitations of cathodic protection. Practical suggestions from field men are indispensable to the future success of this work.

Why Is Control Important?

On our company's main transmission system, many pipe replacements are necessary each year because of corrosion. Replacements represent only a part of the total corrosion costs on most underground pipe lines. Total annual costs are made up of the following main factors:

1. Depreciation of pipe line value.
2. Cost of locating and repairing corrosion leaks.
3. Cost of pipe replacements made necessary because of corrosion.
4. Value of the lost commodity, such as natural gas.
5. Fixed charges on coatings.
6. Fixed charges and operating costs on cathodic protection equipment.

The object of corrosion control programs is to reduce the total annual cost of all items. This usually involves an increase in one or more of the items in order to obtain a greater reduction in the total overall cost.

What Is Corrosion?

Field practice and laboratory experiments have shown that virtually all soil corrosion is due to, or associated with, the flow of electricity. Although, in practice, there are many different and complicated factors encountered, each of which is more or less interdependent on the others, the fundamental theories involved are comparatively simple. It is proposed to present here a simple, non-technical explanation of soil corrosion.

G. R. OLSON

upon graduating from the University of Wisconsin in 1922 with a degree in electrical engineering, joined the staff of the Utah Power and Light Company and remained with that company until 1929—From 1929 to 1934 he was with the electrical consulting division of the Electric Bond and Share Company, his work taking him to various properties of that company, a part of his time being spent in Mexico —In 1934 he transferred to client companies in Bombay, India, where until 1939 he was general superintendent of operations and construction on the interconnecting high-voltage electric power system serving that area—In March, 1939, he was placed in charge of the corrosion department of the United Gas Pipe Line Company, Shreveport, Louisiana.

It is well known that water, when free to flow under the influence of gravity alone, runs downhill or from the point of high to low pressure. If released from a reservoir on high ground, it will run to the valley, but not necessarily in a straight line. It will follow the gullies, depressions, and crevices. In other words, it will follow the path of lowest resistance, although that may be a winding and indirect route. Similarly, electricity flows from points of high to points of low potential by the paths of lowest resistance.

With direct-current electricity, a point of higher potential is said to be positive to points of lower potential, and current flows from the positive toward the negative. Potential in electricity may be compared to pressure in the gas business, and current corresponds to the rate of gas flow.

The resemblance between electricity and water can be visualized by studying a closed circulating water cooling system such as is used at some compressor stations. This is illustrated in simplified form in Fig. 1.

Energy is supplied to the pump "P", which in turn produces a pressure, forcing the water to flow from point "A" to "B". Similarly, due to energy supplied by the pump, the water flows from points of comparatively high pressure, such as at "B", to points of lower pressure, as "C" and "D", through the water jackets of the engine and cooling coils, back to the water pump at "E". It will be noted that in all sections of this circuit, except within the pump itself, water flows from points of high toward points of lower pressure.

Inside the pump the impeller forces the water to flow from points of low to points of higher pressure. This characteristic is also true of electrical circuits, although somewhat more difficult to visualize. Direct-current electricity flows from positive to negative points in the external part of the circuit, but in the opposite direction within a generator or battery. An understanding of these principles is important because corrosion usually involves the flow of electricity within the generator (galvanic cell), whereas cathodic protection usually involves the flow of direct current in circuits external to the generator.

If two pieces of dissimilar metals are placed in a solution (electrolyte) each metal assumes a different electrical potential in relation to the adjacent solution. This may be due to the energy stored in the metal during the process of being converted from an ore to a refined metal. If these dissimilar electrodes are connected by a metal conductor, one of the metals will go into solution and current will flow from it through the electrolyte to the second metal. To illustrate, assume that the metals are zinc and iron as in Fig. 2.

In this case, current will flow from the zinc through the electrolyte to the iron and complete the circuit by way of the external conductor. Hydrogen gas will usually be released at the iron electrode. The zinc will corrode and the iron will be protected. The corroding metal (zinc in this case) is called the

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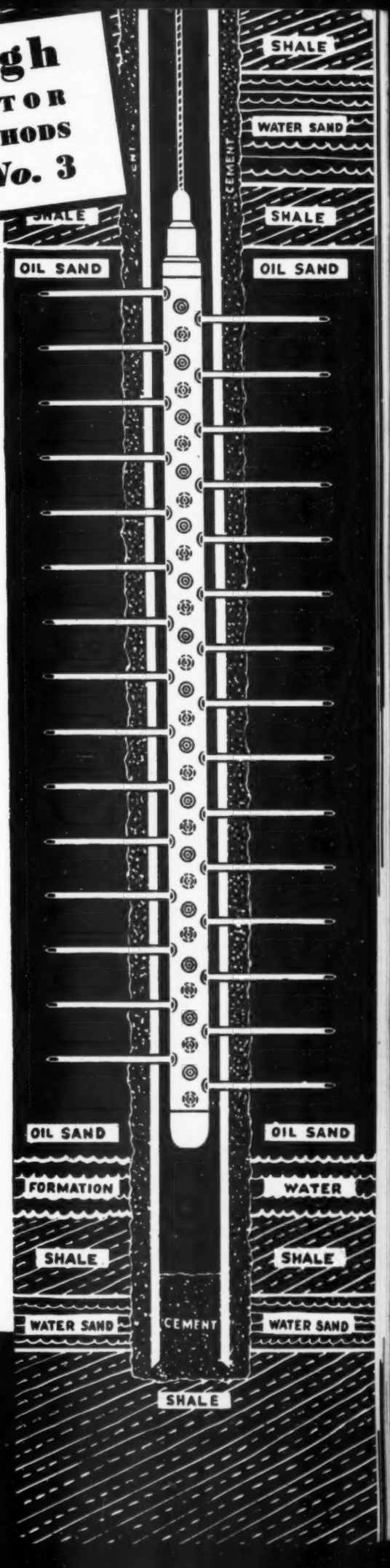

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anode and the protected metal is known as the cathode. This is a galvanic cell and much of the corrosion encountered in practice (galvanic corrosion) is caused by galvanic action similar to that explained above. Galvanic cells are created in many different ways.

The common flash-light battery is a simple form of "galvanic cell". The zinc container acts as the anode and the carbon rod in the center is the cathode with the chemical electrolyte packed around it. When the carbon and zinc terminals are connected together through a load, such as in the lighting of a flash-light bulb, current flows and the inside of the zinc container corrodes.

If two dissimilar metals are connected directly together and buried in the ground, as would be the case when a piece of galvanized pipe (galvanized coating is essentially zinc) is connected to a bare steel pipe, a similar galvanic cell is produced. This is illustrated in Fig. 3.

In this case the soil with its moisture acts as the electrolyte in the galvanic cell and the connection between anode and cathode is made through the pipe coupling. Corrosion of the galvanized pipe is accelerated as shown by the arrows indicating paths of current flow. A galvanized fitting in a steel or iron pipe line will of course react in a similar manner. If soil conditions are favorable and the amount of galvanizing small compared to the steel, the galvanizing will be destroyed in a short time, and similar action, although usually at a reduced rate, may take place on the exposed bright steel.

Another type of galvanic corrosion frequently encountered in practice is illustrated in Fig. 4.

This shows a copper pipe, such as a house service, connected to a steel main. Under these conditions, the steel pipe acts as the anode and the copper pipe is the cathode. Corrosion on the steel pipe is accelerated.

Other dissimilar metals act in a similar manner to zinc and steel although the rate of corrosion on the more soluble metal varies over a wide range, depending on magnitude of solution potential, relative areas of exposed metals, and variations in the composition of the electrolyte or soil.

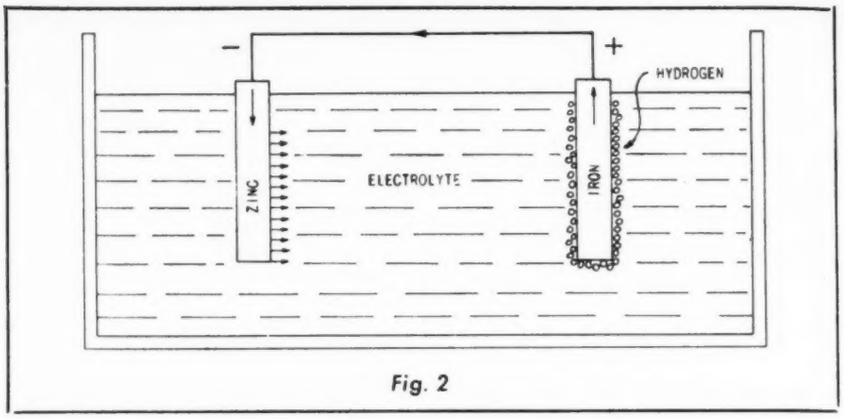


Fig. 2

The metals can be arranged in what is called an "electro-chemical" or "galvanic" series in which the position of each indicates whether it is anodic or cathodic to the other metals. A few of the more commonly known metals are thus arranged below:

Anodic or corroding end
Magnesium
Aluminum
Zinc
Iron and steel
Tin
Lead
Nickel
Brass
Bronze
Copper
Silver
Gold
Platinum
Cathodic or protected end

If any one of these metals, such as magnesium, is connected in an electrolyte, as in Fig. 2, with any metal lower in the series as, for example copper, it will go into solution and corrode. A similar action will take place with any other two metals selected from the series. Of the metals included in this series, the corroding action will be most rapid between magnesium and platinum, as they are the most widely separated in the series. Magnesium corrodes and platinum is protected if connected as a galvanic cell.

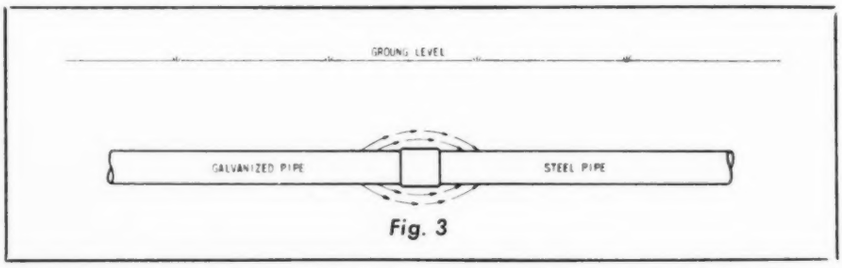
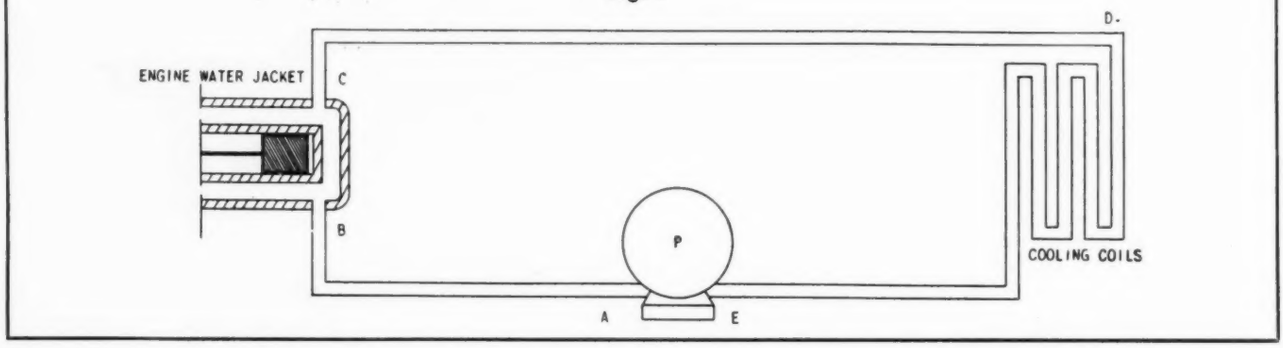


Fig. 3

Slight differences in the composition of metal at different points on the surface of commercial steel pipe cause galvanic currents to flow similar to that described above. These differences may be due to mill scale, stresses set up in handling, and many other causes. This type of galvanic cell is illustrated in Fig. 5.

Point "A" is intended to represent mill scale on the pipe surface, which will usually be less soluble than bare steel. Point "B" represents an unusual stress area caused by mechanical damage to the pipe surface. Corrosion takes place at all points where current leaves the pipe surface and passes into the soil.

Fig. 1



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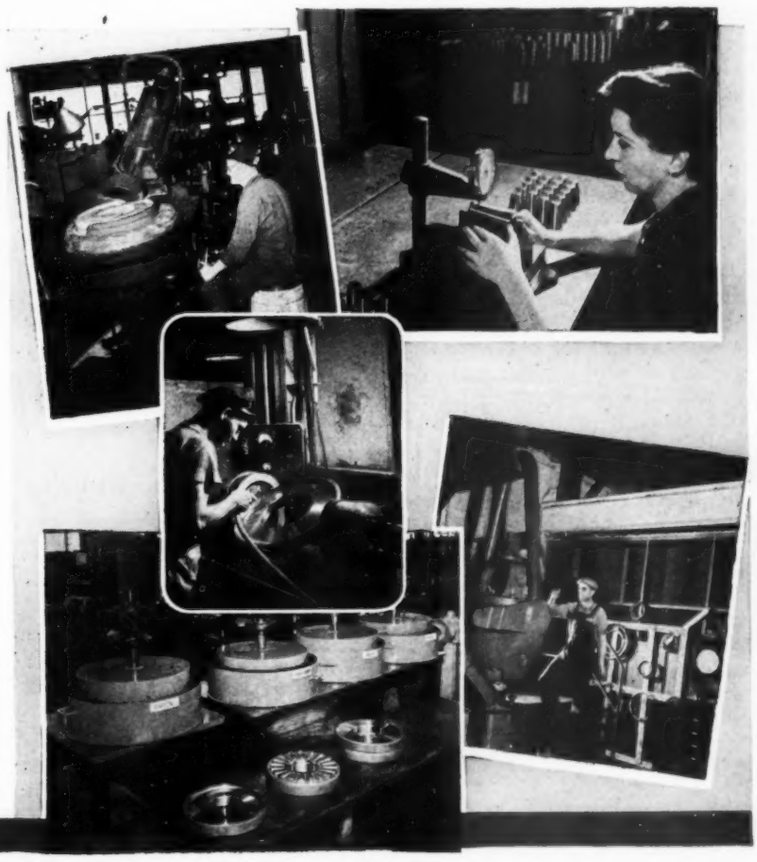

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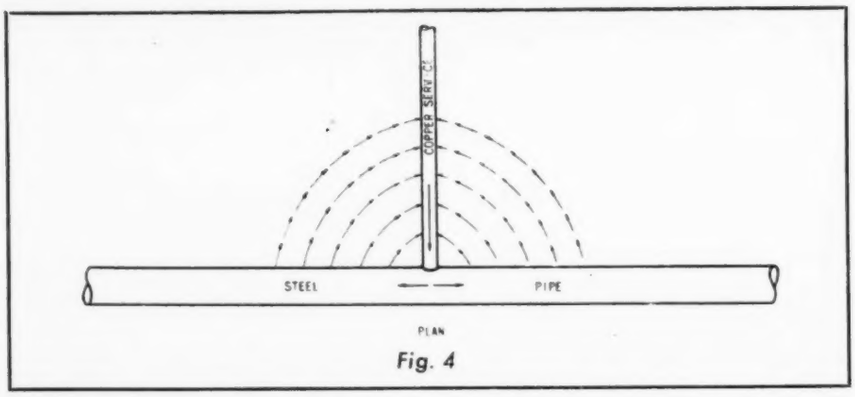


Fig. 4

This type of corrosion can be demonstrated very easily. Select a piece of clean bright steel and strike two or three spots with a sharp tool or take a piece of rusty steel with a few clean, bright spots. Leave these steel samples in an ordinary pan of water a few days, after which the rapidly corroding parts can be seen very easily.

Another common method by which galvanic currents are produced is illustrated in Fig. 6.

In this case the pipe line passes through dissimilar soils that, due to different characteristics, produce potentials of varying magnitude. Current flows from the pipe to soil "A", through soil "A" and "B", and back to the pipe in soil "B". Corrosion results where the current leaves the pipe in soil "A". These are sometimes called long line galvanic currents.

A special case of this type of galvanic corrosion is found where a pipe passes from a dry soil into a marshy area, as shown in Fig. 7. Although the soils may appear similar, the excess moisture in the marsh changes the characteristics of the electrolyte surrounding the pipe. The wet soil tends to exclude the air and reduces the supply of oxygen at the pipe surface. This causes the pipe in that area to be anodic to pipe laid in better aerated soil. The result is long line currents that corrode the pipe in the marsh.

We cannot, because of space limitations, illustrate all the different ways in which galvanic currents may be generated, but that illustrated in Fig. 8 is of particular interest.

In this case, a new line has been laid closely paralleling an old line with the two mechanically connected by a tap line or cross-over. Galvanic currents will usually flow from the new line to the old rusty line, as shown by the arrows. As a result, the old line will be partially protected at the expense of the new. This probably accounts for the occasional report that a new line has apparently corroded more rapidly than an old line on the same right-of-way.

The illustrations point out a few of the ways in which electricity is generated in underground pipe lines. With small scale models, they can all be demonstrated very easily in the laboratory. In actual practice, the magnitude of currents flowing varies over a wide range due to soil and seasonal variations. Actual field corrosion is frequently the result of a combination of two or more types of galvanic cells and therefore difficult to measure accurately. Where a pipe starts to corrode, however, an electric current is always being discharged into the surrounding soil. A piece of pipe metal subject to corrosion may be illustrated as in Fig. 9.

In "A", electricity or current is represented by an arrow beginning to leave the metal to flow into the soil. As it leaves, it grabs a particle (or ion) of iron and drags it free of the pipe as shown in "B". The instant the small particle of iron is free, the air rushes in and takes the small piece of iron from the electric current. The oxygen in the air combines with the iron "C" to form rust. The chemist calls this "iron oxide". This action continues as long as the current flows. In time, a definite pit will be found if the accumulation of rust is scraped off as in "D".

Why does a pipe pit? It doesn't corrode evenly over the surface because the current doesn't leave the metal surface at all points. Two reasons why currents do not leave the pipe uniformly over its surface are illustrated in Figs. 10 and 11.

Fig. 10 represents a section of pipe that had a mill primer or some form of insulating film applied before burial. This film resists current flow much the same as a dam resists water flow. The current flows by the path of least resistance or through "holidays" in the coating. Hence, pitting frequently seems to appear at random points.

When the quality of the coating used is improved, there are fewer "holidays" and fewer points of corrosion attack, but as the total area subject to corrosion is reduced, the density of current discharge is usually increased somewhat. This causes more rapid pitting over a smaller surface. For this reason, under similar conditions, a coated line will sometimes develop its first corrosion leak in a shorter period than a similar bare or uncoated line.

As shown in Fig. 11, the pipe does not contact the soil uniformly over its entire metal surface. In all soils there are some voids or air spaces between particles of soil. These voids may be filled with water when the pipe is installed below the permanent moisture level. In any case, the voids usually offer different resistance to current flow than the points of actual contact to soil, with the result that corrosion is not uniform. Also, a clod of soil or a tree root pressing against the pipe will tend to shield the underlying surface from the free access of oxygen and may cause it to become anodic to the surrounding pipe surface.

Electrolysis

The types of corrosion described are frequently confused with electrolysis, which is the decomposition of metal caused by an applied direct current

Fig. 5

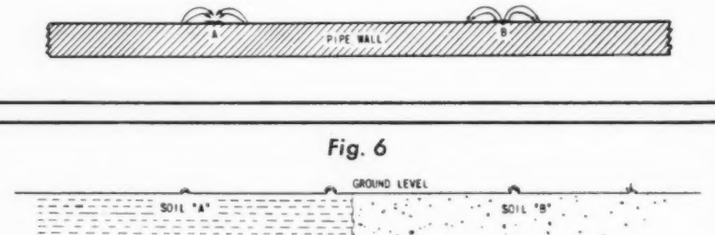
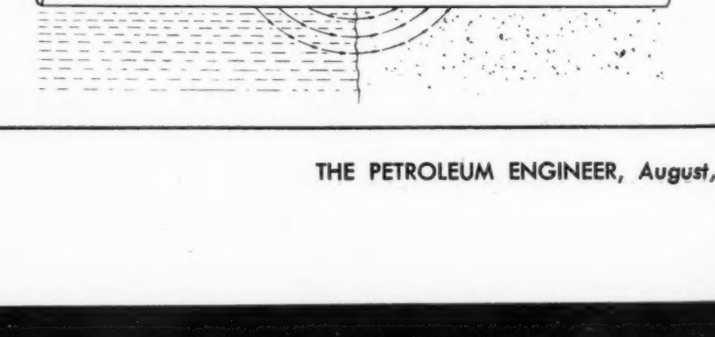


Fig. 6



Solid rounds of alloy steel for 75mm. gun-barrels are pierced on a pipe mill by J & L skilled workmen.

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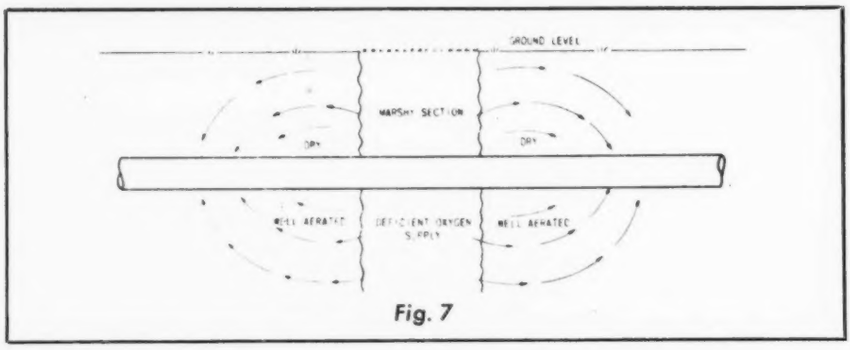


Fig. 7

from some external source. In practice, this type of corrosion is usually caused by stray ground return currents from electric railroads or other sources of direct current generation. The stray currents in returning to the negative buss of the generator tend to concentrate in the paths of lower resistance, which may include underground pipe lines in that vicinity. Fig. 12 represents such an electric railway system.

The main streetcar generators are represented by "A" and the power current flows out on the overhead trolley cable "B" where it is used by the train or streetcar "C". From "C" the current returns to the main station by the paths of lowest electrical resistance. The track rails are usually made electrically continuous in an effort to make them carry as much of the current as economically possible. Due to the large volume of currents involved in such systems and the relatively low resistance between tracks and earth, however, an appreciable part of this current frequently returns through the soil to generator "A".

If an underground pipe line is situated close to the tracks, it may pick up return railway current at or near "E" and discharge it near "F", or in the vicinity of the generating station. This stray current will reduce corrosion of the pipe near "E", but will cause accelerated corrosion near "F", which is termed "electrolysis". This type of corrosion has become less serious in recent years due to replacement of electric railway systems with trackless trolleys and motor buses.

Electrolysis may also be caused by stray ground currents from any other type of d-c. generating equipment such as cathodic protection installations owned by other companies. This is usually easy to control by installing drainage connections or cross-bonds after determining the requirements for each location by field tests. It is important, however, that each possible source of stray current be carefully investigated in the vicinity of pipe lines subject to corrosion.

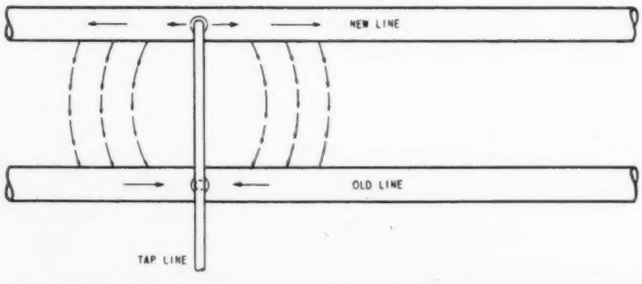
The local operator with his intimate knowledge of the surrounding country can be very helpful in calling the corrosion engineer's attention to possible sources of stray ground current. Each individual case should be investigated in the field by experienced personnel in order to determine the proper corrective measure.

What Is Cathodic Protection?

We have shown how corrosion is associated with direct current passing into the soil from the pipe surface. It follows that if all current can be prevented from leaving the pipe surface, corrosion will be stopped. In cathodic protection, this is accomplished by using an external source of power to cause current to flow from the soil to the pipe. These cathodic protection currents must be of sufficient magnitude to overcome the corrosion currents that are trying to leave the pipe.

In Fig. 13 is illustrated a section of pipe with so-called "hot spots" at frequent intervals as indicated by the arrows pointing away from the pipe. These small arrows represent corrosion currents. An anode or ground bed, usually consisting of old used pipe, is installed in the ground off to the side of the pipe, such as at point "A". The positive side of a d-c. generator "B" is then connected to the ground bed and the negative to the pipe line. This external source of direct current is usually a rectifier, or a gas engine or windmill driven generator. The current flows from the positive terminal of this generator to the ground anode. From there it passes into the earth and flows to the pipe line, on which it is collected and transported to a point near the generator where it is harmlessly removed through the drain cable. As corrosion currents are relatively small, a reasonable amount of cathodic protection current is usually sufficient to overcome them. One of the chief difficulties encountered in practical installations is that of getting the necessary current density distributed at the proper points or areas. Usually it is necessary to apply an appreciable amount of cathodic protection current to non-corroding areas in order to obtain sufficient density in the corrosive areas or "hot spots."

Fig. 8



Cathodic Protection Practices

The following is intended to cover only the general features of practical installations for cathodic protection.

Coupling bonds. Before cathodic protection can be installed on a line, steps must be taken to see that the pipe itself will act as a low resistance path for the flow of current returning to the generator negative. If the line is solid welded, this is already accomplished for the relatively large cross-section of steel forms a good low-resistance electrical conductor. If the line is Dresser coupled, however, it is necessary to install bonds around each coupling to prevent the rubber gaskets from acting as electrical insulators between successive joints of pipe. The most satisfactory type of bond is made of flexible strap steel electrically welded to the pipe and coupling center ring. Copper bonds with brazed connections have also been used with some success, though they are more difficult to install satisfactorily and, due to the proximity of dissimilar metals, special care should be taken to prevent galvanic action.

Fig. 14 illustrates paths of current if cathodic protection is applied to a section of line containing unbonded high-resistance couplings.

Cathodic protection currents will flow about the same as in the usual installation and reduce corrosion on the main body of the pipe. The return currents in the pipe, when approaching a high-resistance coupling, however, will leave the pipe and travel around the joint. This will concentrate and greatly accelerate corrosion at the points where current passes from the pipe into the soil as "A", "B", "C", and "D".

For these reasons, it is essential that

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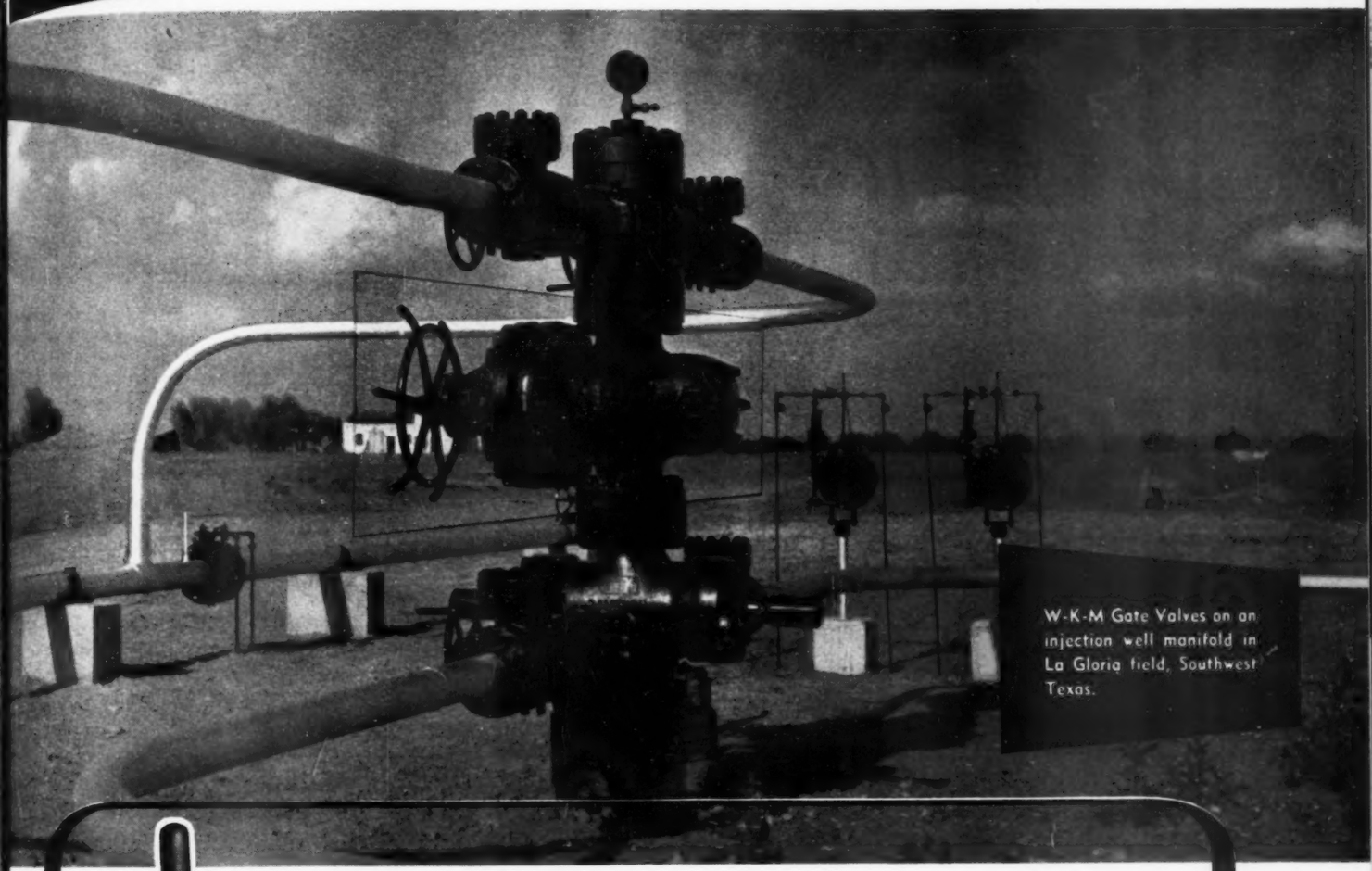

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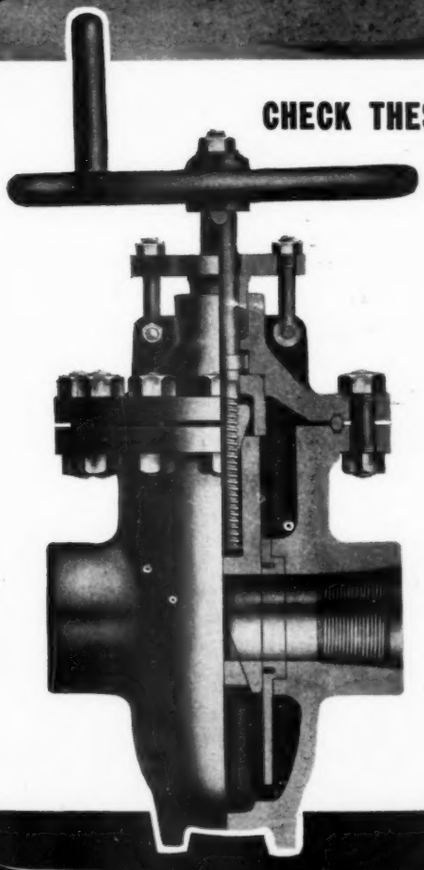

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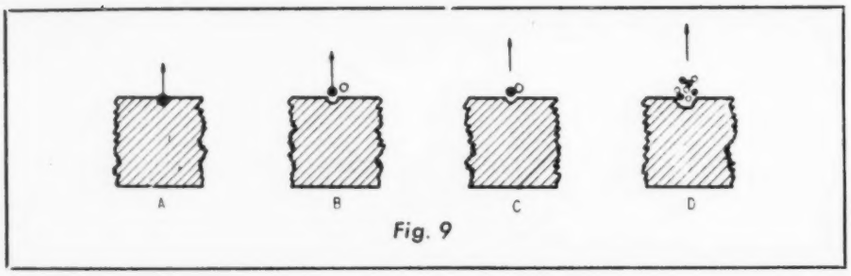

Fig. 9

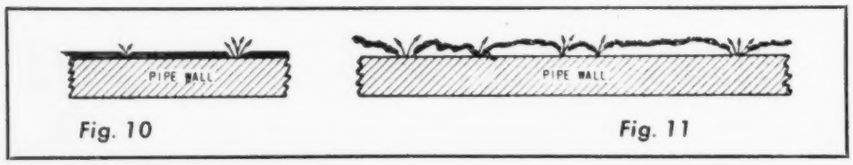

Fig. 10 Fig. 11

special care be exercised in bonding couplings for new installations and that open bonds be found and repaired promptly on existing sections of pipe line that are electrically protected. The seriousness of open bonds in protected sections of line can be appreciated when it is realized that only one ampere flowing from pipe to soil can carry about 5 lb. of steel into solution in three months.

Ground beds or anodes. The vital importance of ground beds is appreciated when it is realized that:

1. The characteristics and location of ground beds determine the density and distribution of cathodic protection currents and hence the success or failure of corrosion control.

2. In the best designed and constructed installation, at least 50 percent of the total energy losses occur in the ground bed.

To date, very little real improvement has been realized in ground bed design. This is because of the many variables encountered, each of which is interdependent upon the other, in determining the size, type, and location of ground beds. The most important of these variables are soil resistance and composition, which affect the ground bed losses and current requirements for adequate protection, moisture, or seasonal variations, and coating or contact resistance between pipe and soil.

Used steel pipe and carbon or graphite rods are the most commonly used materials for ground anodes. To date, due to availability of material at a reasonable cost, used pipe has proved the most economical on many systems. At some future date, reduced cost of carbon rods may be realized, which will make them more economical as compared to used pipe.

Although past ground bed development is disappointing, a number of improvements has been made in methods of locating and installing anodes that are of material benefit.

When installing ground beds, it is very important that the detail specification for each particular installation be followed closely and that an accurate inventory be made of the details of each anode. These data, together with the monthly operating records, are invaluable in determining the benefits derived from design changes that are made from time to time.

For several years now a number of engineers and laboratory technicians have been working on ideas for ground bed design, which, if successful, will have a very marked effect on cathodic protection application technique. Laboratory experiments have been fairly successful, but to date field application problems have not been solved. Although too much confidence should not be placed in such developments, it is hoped that substantial improvements will be realized in the near future.

Power units. From a technical and theoretical standpoint, any source of direct current of suitable voltage and capacity may be used for cathodic protection. In practice, however, many factors must be taken into account in selecting the most economical power unit for each job.

Windmills have, in the past, been tried quite extensively. Certain types are easy to maintain and they provide very low cost electric power. Even when carefully located and installed, however, their output varies over a wide range and, due to lack of wind, they frequently stop altogether. Experience with all types of units shows quite definitely that successful results will not be obtained unless the cathodic unit is maintained in continuous service at the desired output for at least 90 percent of the time each month. Windmill-driven generators cannot be expected to provide entirely satisfactory corrosion control and are most profitably used in special cases.

Gas engine driven generators have been used with considerable success for many years, but the operation and maintenance costs are relatively high. They are used at locations where a reliable source of a-c. electric power is not available. Manufacturers have been encouraged in the development of a suitable unit for this type of service and very definite improvements have already been realized. If and when a unit of this type is available that will give 90 percent or better continuous operation, with an average of one inspection per month, then this type of unit will be in a better position to compete economically with rectifier units.

A striking practical example of what can be accomplished with gas engine cathodic protection units of a type that we now consider "old style" is found in the record of 16 units, most of which were installed during the years 1936 and 1937. During those years these units were operated and maintained more or less as a side issue and, although the exact hours of operation are not recorded, it is definitely known that they were in service less than 75 percent of the time. Some time about the middle of 1938 regular and adequate maintenance attention was provided and the average percent operation of all units has been maintained above 90 percent continuously since that time.

These 16 units provide full protection to a total of 35.8 miles of pipe and partial protection to a total of 49.7 miles of large-diameter pipe line. By full protection is meant those sections where, with normal unit output, the pipe-to-soil potential is maintained at or above 0.8 volt. Partial protection includes those sections of pipe where normal output of the units provides some current drainage, but not sufficient to raise the pipe-to-soil potential to the desired 0.8 volt. The following tabulation

Fig. 12

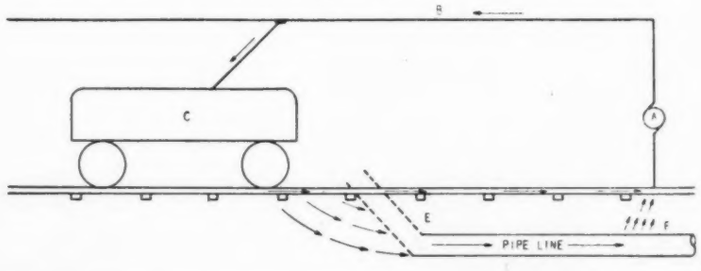

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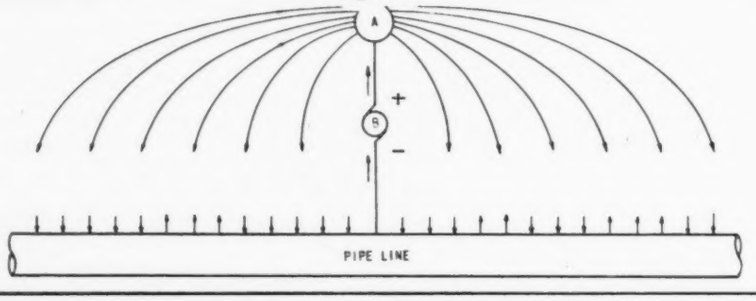
Fig. 13



shows the corrosion leaks repaired in these sections of pipe to date:

Year	Fully protected sections totaling 35.8 miles of pipe	Partially protected sections totaling 49.7 miles of pipe
1937	130	103
1938	242	196
1939	17	31
1940	8	16
1941	7	9
1942	6	5

It will be noted that, although most of the units were in operation in 1936 and 1937, corrosion leaks continued to increase until the monthly percent operation was increased to 90 percent or better. From that time on there has been a very marked decrease in corrosion leaks; namely, from 438 in 1938 to 11 in 1942. It is very evident to the practical man that extensive reconditioning or replacement work would undoubtedly have been necessary on these sections of line if the cathodic protection units had not been operated effectively and continuously. Similar data are of course available on many other installations.

Rectifier units. At the present time, dry disk or plate type rectifiers are the most economical and satisfactory to use for cathodic protection at all locations where a-c. electric power is available. The principal reason for this is that there are no moving parts requiring extensive maintenance and very reliable and nearly continuous operation can be obtained with minimum attention by the operating personnel. In the protection of large-diameter bare lines where power requirements are large, it is usually economical to purchase a-c. electric power in bulk at one point and distribute along the pipe line right-of-way by means of a specially constructed electric power line. The new designs that have been developed for this purpose during the last few years have materially reduced installation costs and at the same time increased flexibility for making field adjustments.

Zinc and magnesium anodes. Plates or rods made of zinc, magnesium, or other metals high in the electrochemical series can be used to replace the ground bed and power units of cathodic protection. This is accomplished by utilizing the principle illustrated in Fig. 2. Zinc has been used for this purpose on a relatively large scale for application on bare as well as coated lines. The zinc is usually in the form of a rod about 1⅜ in. in diameter and 5 ft. long, with a ¼-in. steel core. These rods are driven into the soil a suitable distance from the pipe and connected to it by insulated conductors. The soil then acts as the electrolyte, in Fig. 2, and current flows through the soil from the zinc to the surface of the pipe, neutralizing corrosion currents. The steel pipe is protected at the expense of the zinc. In protecting 6-in. to 8-in. bare pipe, the zinc rods are usually spaced about 8 to 10 ft. apart or about 530 per mile. Practical installations indicate the average life of the zinc rods may be about 10 years. With coated lines, a single rod will sometimes protect 500 ft. or more of large-diameter pipe.

Magnesium rods have also been used for small experimental installations. Deterioration of magnesium is much more rapid than zinc, however, and extensive experiments are being conducted to increase their life when used for this purpose.

After the war, due to increased production facilities, it is believed that prices for these metals, particularly magnesium, will be greatly reduced, making them more economical to use for cathodic protection.

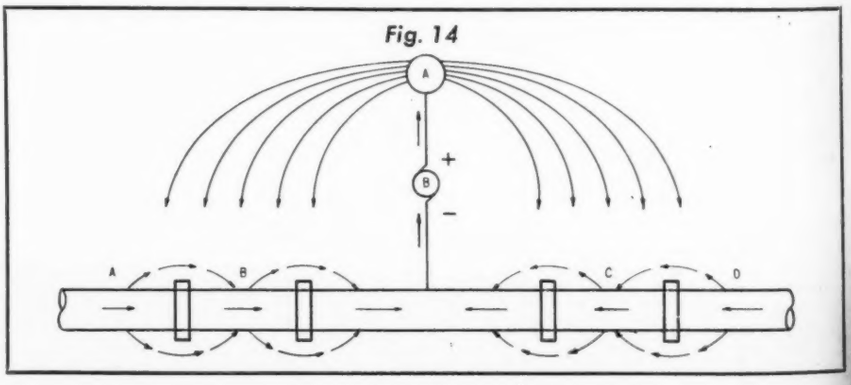
When Is Corrosion Stopped?

Laboratory experiments have proved rather conclusively that complete stoppage of corrosion can be obtained under the most serious conditions if sufficient well-distributed current (cathodic protection) is applied to the underground metallic structure. As a result of experience with many field installations, this fact is rather generally accepted by practical men in the industry. However, the power requirements, and hence the cost of obtaining such full protection may, in some areas, be prohibitive. In any case, the most economical installation on a pipe line is that which will give the lowest average annual cost of maintaining the pipe in service for that term of years for which it is required. The exact percentage of full protection that is most economical for any given installation cannot, at the present time, be accurately determined for several reasons, but it is probably considerably less than 100 percent.

To date, no simple means has been found for measuring the degree of corrosion control obtained at any point on a pipe that is under cathodic protection. Several methods of field measurements are available, however, that indicate approximately when satisfactory corrosion control is being obtained. The most commonly used method is by pipe-to-soil potential measurements. Years of experience has shown that if sufficient current is applied to establish and maintain a potential of 0.8 volt or more between the pipe and a copper-sulphate electrode placed at the surface of the ground directly over the pipe, satisfactory corrosion control is usually obtained. Experience also shows that in some cases, substantial reduction in corrosion leaks has been realized where the pipe-to-soil potentials as measured in this manner have been maintained at less than 0.8 volt. Generally speaking, pipe-to-soil potential measurements are a good guide in making unit adjustments, but the final answer regarding the degree of corrosion control is always reflected in the leak repair record. This may require from one to several years to determine, depending on the promptness in locating and repairing corrosion leaks.

It should be pointed out that cathodic protection is of course in no way effective in replacing metal that has been removed from the pipe by corro-

Fig. 14



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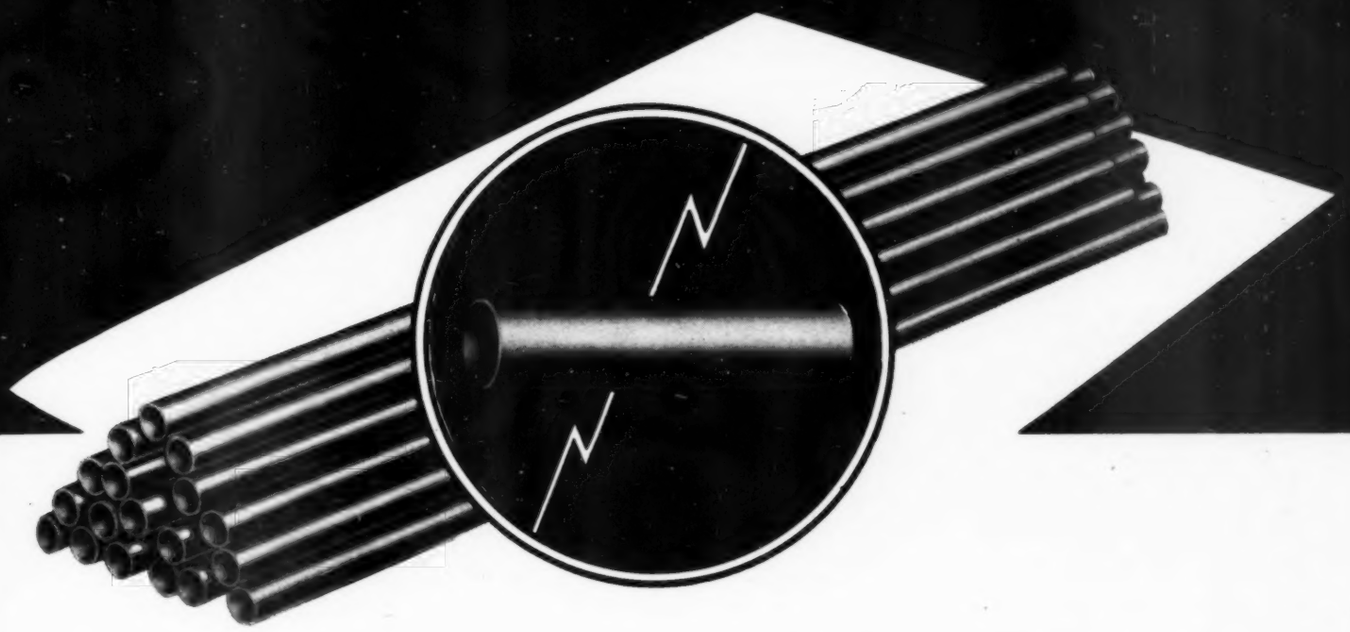

CONTROLLED uniformity of Talon's Electric Welded Steel Tubing begins with the desired chemical and physical specifications of the hot-rolled strip from which it is formed. It assures safety, ease of fabrication, great strength, and low cost. Close gauge tolerances guarantee uniform wall thickness, concentricity, and unvarying light weight. No surface defects are hidden. Both the inside and outside surfaces undergo constant inspection from production of the strip, through the cold-forming operation on the tube mill, to final inspection. Every foot is hydrostatically tested to withstand tremendous pressure. Size is held consistently on long runs of a given diameter by micro-gauge adjustment of the forming rolls. Talon's Electric Welded Steel Tubing is now made in most sizes from ¾" to 4" O. D.—up to 60 feet in length. These and other sizes will be available for your peacetime production at low cost.

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STEEL TUBE DIVISION **OIL CITY, PENNA.**

sion before protection is applied. Increased operating pressure will of course cause leaks to occur at such weak spots and often confuse the picture as shown by the leak records relative to effectiveness of protection.

When to Use

It is believed that most installations made to date were initiated for one of two reasons:

1. On bare and poorly coated sections of lines that had become so seriously corroded as to require reconditioning or replacement unless corrosion were brought under control quickly.

2. On coated and bare sections of lines at river crossings, in swampy areas or other inaccessible locations where leak repairs, if and when they occur, would be very expensive.

The long-term economics of each proposed installation should be studied very carefully with particular attention to the probable length of time it will be desirable or necessary to maintain the line in service. Studies of this kind usually include long-term estimates of the probable average annual cost of maintaining the section of line in service under these probable plans:

1. Continue to repair leaks as they occur and make short replacements only as and when necessary.

2. Complete reconditioning or replacement with coating of the entire section of line under consideration combined with leak repairs as they occur in future years.

3. Complete reconditioning or replacement with coating and supplemented with cathodic protection.

4. Application of cathodic protection to the section of line with no reconditioning or coating.

Detail statistical data covering corrosion leak and replacement history of pipe lines are essential in making studies of this kind.

Recent experience indicates quite definitely that the latest designs are effective and economical for installations on bare lines 8 in. and larger in diameter as an alternative to reconditioning or replacing old lines. This, of course, depends on several conditions that must be considered in connection with each proposal, the most important of which is probably the availability of low-cost a-c. electric power. With the rapid development that is taking place, it is hoped that installation and maintenance costs will soon be lowered further to place cathodic protection in an even better position to compete with other methods of corrosion control.

EDITOR'S NOTE: This article has been given limited distribution previously in the *United Gas Log*, which is circulated only to employees of the United Gas Pipe Line Company.

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P 094.13

Proper Handling of Wire Rope for Maximum Service

IF you are a user of wire rope, as many oil men are, and if you have ever had trouble with kinks in such rope, the accompanying illustrations will be of value to you. Or, if you are a prospective user they show what to guard against. To obtain maximum service from a wire rope careful attention should always be given to methods of handling as indicated in the drawings.

Fig. 1 shows how wire rope should *not* be uncoiled, and how it *should* be uncoiled. Fig. 2 shows the wrong way and the right way of unreeling reels. Fig. 3 shows how a kink starts, how the rope kinks, and how it looks after it is straightened out. When the kink in a wire rope is straightened, the wires may or may not be broken — but the damage is done. The rope has been weakened, and when put to work the wires may soon break. Never use a wire rope that has been kinked unless you completely cut out the kinked portion.

(Permission to reproduce these illustrations was granted by Columbia Steel Company, subsidiary of the United States Steel Corporation.)

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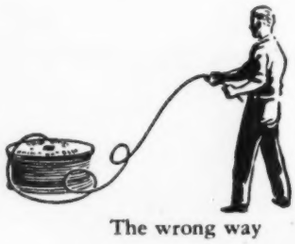
Fig. 1

The wrong way

The right way

Fig. 2



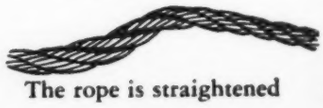
The wrong way

The right way

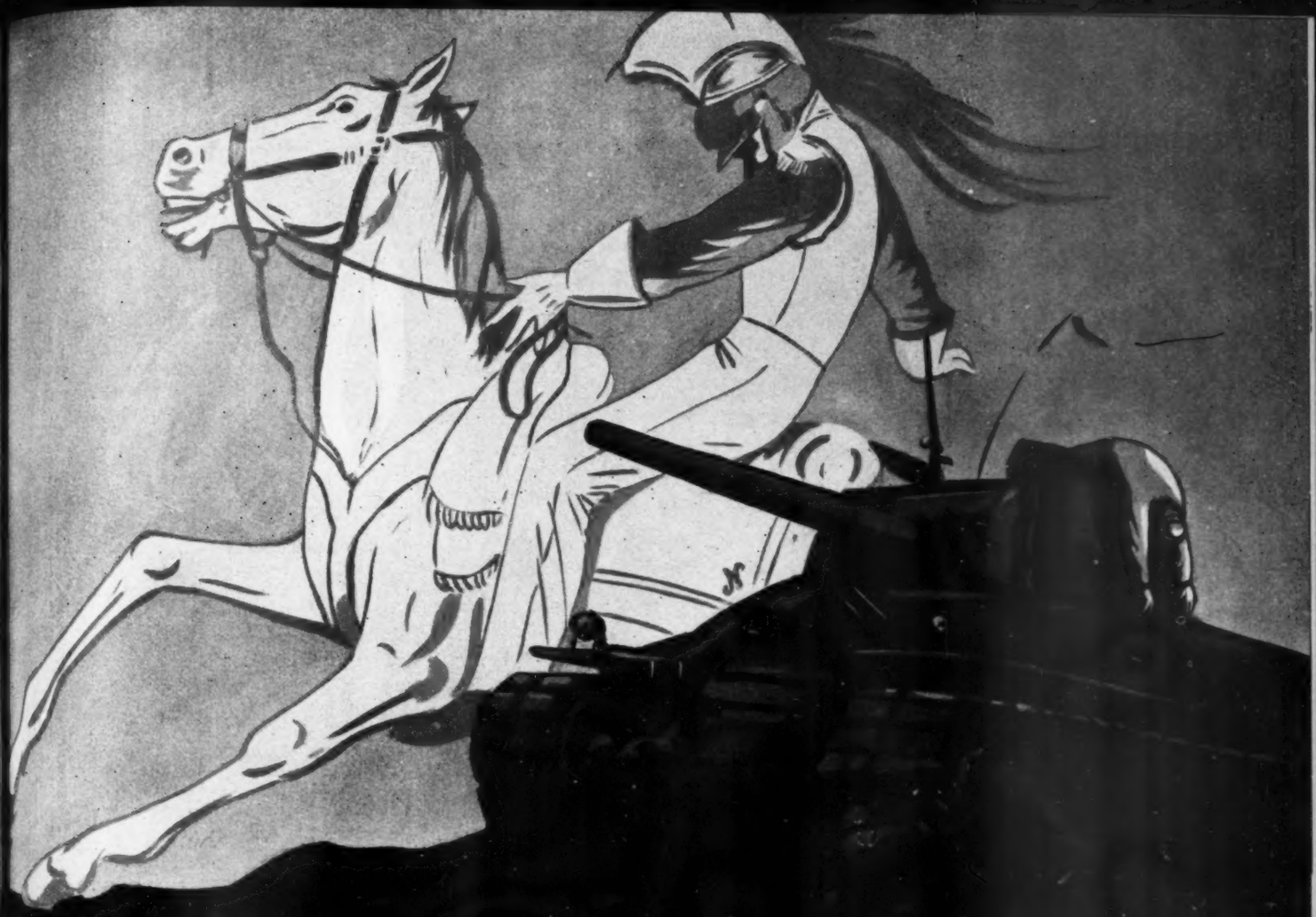
Fig. 3

The way a kink starts

The rope is kinked



The rope is straightened



For want of a shoe . . .

For the want of a nail the shoe was lost,
For the want of a shoe the horse was lost,
For the want of a horse the rider was lost,
For the want of a rider the battle was lost,
For the want of a battle the kingdom was lost—
All for the want of a horseshoe nail.

ANON.

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IT IS A TRUISM—to carry on successful military operations, an army must establish lines of communication and supply. Not only must the ammunition be there to pass when the guns begin to fire, but great quantities of food, engineer equipment and supplies must be moved up to depots established behind the battle lines. There must be shops to repair disabled equipment if the battles are to be won. ★ Rodgers Hydraulic Track Presses may be found in operation on every battle front. This equipment is recommended and approved by every manufacturer of crawler type tractors. ***If it's a Rodgers, it's the best in Hydraulics.*** Rodgers Hydraulic Inc., St. Louis Park, Minneapolis, Minnesota.

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Handling pipe at a river crossing. Strips of lath wired to the pipe prevent damage to coating and wrapper when pulling into place

Pipe Line Supplies Fuel to War Industries

PETROLEUM ENGINEER Exclusive

☆ **Difficulties overcome in constructing combination 12¾-in. and 18-in. gas line**

by Frank H. Love
Managing Editor

ALTHOUGH it has been in partial operation for several months, the supply of gas to the 135-mile pipe line laid by the Arkansas Louisiana Gas Company from the Dorcheat-Macedonia field, Arkansas, north into central Arkansas, has been increased. The additional supply is coming from a recently completed gas purification and hydrocarbon extraction plant. This new project, when it attains maximum operation will supply the line with a daily total of about 81,000,000 cu. ft. of gas. The gas is being used as fuel by war and other essential industries, but inasmuch as the line is tied into the company's main system, it will be utilized to augment peace-time requirements after the war.

The line consists of 91 miles of 18-in.

Photographs by J. E. Hampson, Arkansas Natural Gas Companies

Much of the pipe was transported by barge to points near the right-of-way and unloaded in yards

Announcing

After 27 years continuous operation, first as Wheatley Brothers, and later as Wheatley Bros. Pump & Valve Mfrs., we are pleased to announce the change of the name of this company which, effective immediately, will be known as:

FRANK WHEATLEY PUMP & VALVE MFR.

For more than a quarter-century this company has pioneered in the production of oil field and pipe line equipment. Combining engineering research, manufacturing skill and practical field experience has brought many important developments in the products made by this firm.

And while continuing to produce our complete line of pipe line equipment and supplies, we have been privileged the past two years to manufacture special materials for the United States Army and Navy and the world-famous War Emergency Pipe Line.

With expanded plant capacity and increased equipment and facilities purchased to produce vitally needed war materials on which contracts have been completed, we are now in a position to make immediate deliveries of most of our products.

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• PIPE LINE SUPPLIES •

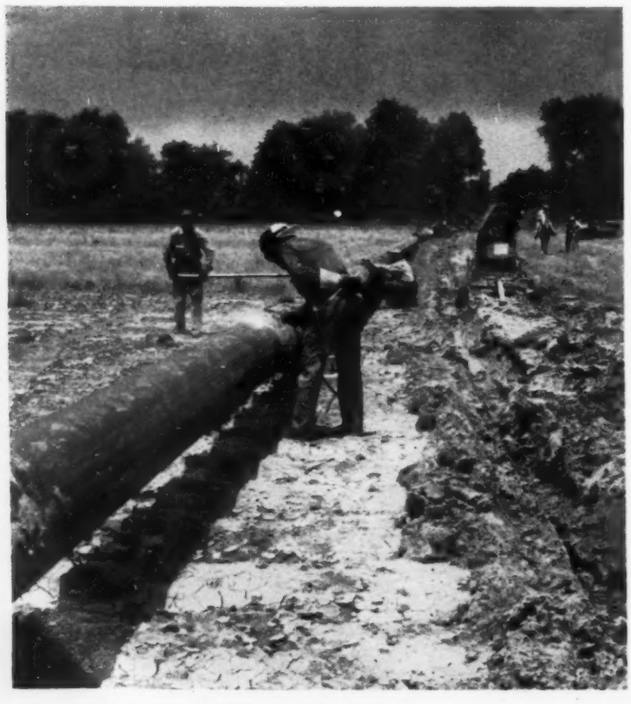
TULSA 6, OKLAHOMA, U.S.A.

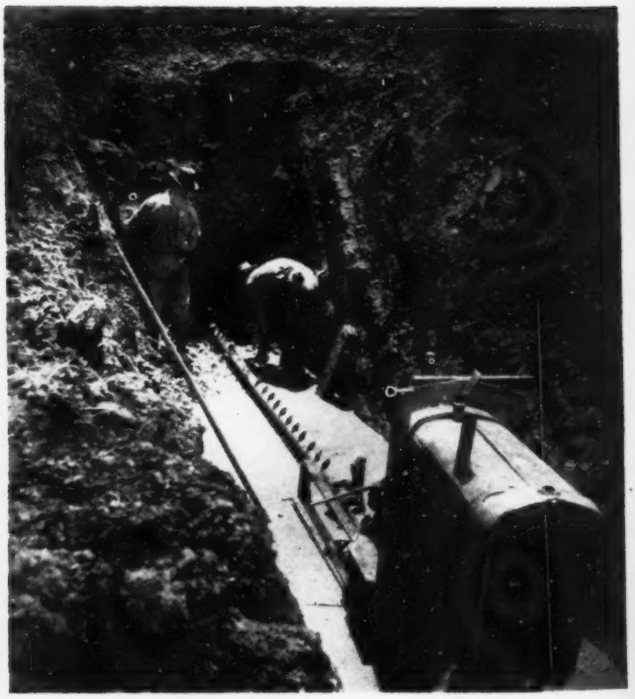
The entire line was coated but only the "hot spots" were wrapped. At the left a traveling-type machine performs both operations simultaneously. On the 18-in. section of the line a coupling was used every fourth joint. The equipment shown in the photograph at the right permits the coating machine to negotiate coupled joints without interruption

and 44 miles of 12¾-in. pipe. Construction was under difficult conditions, blizzards and high water being the principal obstacles. On one section overflow made it impossible for the stringing crews to get nearer to the right-of-way than one and one-half miles and to overcome this difficulty mule teams were pressed into service, pulling in a joint at a time. Ditching could be accomplished only with back-hoes, as the water was 6 in. to 1 ft. deep. Prior to lowering-in coffer dams were constructed every 800 to 1000 ft. and the water pumped from the trench.

In the course of construction it was necessary to lay three multiple river crossings, varying in length from 600 to 1600 ft. All crossings were made of 10-in. pipe. Quadruple lines were laid across two of the rivers and double lines across the third. On all crossings welding was done on shore and the pipe pulled into place. First, however, lath strips were wired to the pipe to prevent damage to the wrapper and coating. One of the rivers is a navigable stream

The line was welded by the electric arc-welding method (left). Railroad and main highway crossings were bored. The machine in the picture at the right did this work rapidly and efficiently





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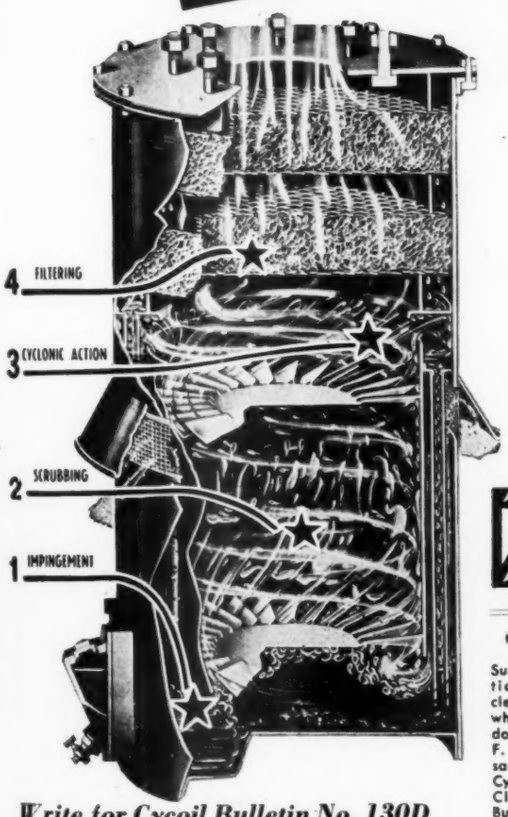

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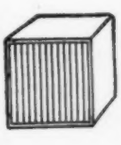
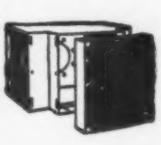


TYPE OCH FILTER
Complete assembly consisting of washable viscous impingement type filters. 1, 2, 3, or more cells are used, depending upon job. Ask for Bulletin 120D.



AMERICAN *Cycoil* AIR and GAS CLEANERS

and in this instance the pipe had to be buried a specified depth below the river bed. For this purpose pumps were mounted on barges and sand and silt pumped from beneath the pipe after it was lowered, allowing it to settle the required depth. In making the other crossings the pipe was left resting on the river bed, eventually to be covered by the action of the current.

To prevent the line from floating river clamps weighing 1000 lb. each were placed on the pipe at 20 to 25 ft. intervals. The crossings were all coated and wrapped.

Another interesting part of the job was the construction of two overhead drainage canal crossings. These suspension bridges, which are 125 ft. in length, were erected because of the "hot" soil in these particular localities. The towers, approximately 20 ft. high, were fabricated of reclaimed 18-in. pipe. Each bridge has two suspension cables and two wind braces.

The 18-in. part of the line is combination welded and coupled, a Dresser coupling being used every fourth joint. The 12¾-in. pipe is solid welded. The entire line was coated, but only at the "hot" spots was a wrapper added.

Midwestern Engineering and Construction Company, Tulsa, Oklahoma, was the contractor.

☆ ☆ ☆

A feature of the line's construction was the several river crossings. To weight the pipe 1000-lb. river clamps were installed every 20 to 25 ft. (left). Below is a dredge used in burying the line in a navigable river

AND NOW

Another Flag

WAR DEPARTMENT
OFFICE OF THE UNDER SECRETARY
WASHINGTON, D.C.
May 29, 1943
To the Men and Women
of the American Well & Prospecting Company
Corsicana, Texas
This is to inform you that the Army and Navy are conferring upon you the Army-Navy Production Award for your fine record in the production of war equipment.
The award consists of a flag to be flown above your plant and a lapel pin which every man and woman in your plant may wear as a symbol of high contribution to American freedom.
This award is your nation's tribute to your patriotism and to your great work in backing up our soldiers on the fighting fronts. I have full confidence that your present high achievement is indicative of what you will do in the future.
Sincerely yours,
Robert P. Patterson
Under Secretary of War
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. . . FLIES WITH "OLD GLORY" FROM AMERICAN WELL AND PROSPECTING COMPANY'S FLAGSTAFF . . .

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We pledge ourselves not only to maintain the high standards upon which this award was based, but to constantly strive to increase our efficiency and production of Bombs for the Army, Ship Parts for the Maritime Commission, Pumps and Steel Castings for the Navy, until the peace is won.

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High-Capacity Ball Reciprocating Bearing

PETROLEUM ENGINEER Exclusive Feature

☆ Improved design allowing greater number of balls increases capacity of bearing

by S. R. Thomas

Chief Engineer, Bantam Bearings Division, The Torrington Company

WHAT has commonly been called a "Ball Reciprocating Bearing" by manufacturers of such, no doubt leaves some persons with a somewhat vague idea of what is meant. A more appropriate, but lengthier, name would be "A Bearing Capable of Both Rotation and Axial Reciprocation."

Obviously such a bearing cannot have definite ball tracks or grooves. Sometimes rotation only is called for and sometimes axial reciprocation alone is desired. For this reason the outer raceway is a true hardened and ground cylinder. The inner race is either the O.D. of a cylinder or the surface of a hardened and ground shaft. The balls naturally lie between the two surfaces and are generally retained in pockets of a metal cylinder serving as a retainer.

It is well known that a ball pressed against a flat plate, or especially against a surface whose curvature is opposite to that of the ball radius, has less load-carrying ability than when the same ball is placed in a groove similar to that of a conventional Conrad type ball bearing. This ratio lies somewhere in the neighborhood of 1 to 10.

In order, therefore, to procure the greatest load-carrying capacity for a given size of bearing, few alternatives are left to try. One of these is to provide the highest possible hardness and uniformity of parts, in view of the fact that all contacts are minute ellipses of very limited area, and the harder the parts, the greater the unit pressure that can be applied. Another is accuracy of manufacture and proper design to distribute the load uniformly over the bearing.

The third alternative, however, is the main subject of this article. By finding a means of increasing the number of balls in the same size bearing, a proportionate gain in capacity is attained. Consequently, if it is possible to install twice the number of balls, the capacity of the bearing is doubled.

On April 13, 1943, the Bantam Bearings Division of The Torrington Company was granted U. S. Letters Patent No. 2,316,468 as just such a means of increasing, in fact, doubling the capacity of this type of bearing as it was known up to that time. The usual ball cage was, as stated before, a cylinder of bronze, steel, or aluminum, laid out and drilled to form ball pockets of the greatest number per inch of cylinder length.

New Construction

The new Bantam construction consists of spirals of balls separated by coils of a specially formed helical spring as illustrated in Fig. 1. The section of this wire may be triangular, round, square, or rectangular, but by making it hour-glass shaped, it not only facilitates loading the balls but retains them during shipping and installation between the races.

Fig. 2 shows the conventional type of ball retainer and it is apparent that the number of balls is limited by the space necessarily needed by retainer metal for spinning or staking the balls in place. From a cost standpoint, the conventional type of retainer is higher than the new Bantam type, not only from a material and weight standpoint but also from a fabrication point of view.

Referring again to Fig. 1, it will be noted that the balls are restrained from end exit by the formed ends of the helix. When this bearing is used in rota-

(Continued on Page 119)

Fig. 1. New bearing construction consisting of spirals of balls separated by coils of a specially formed helical spring.

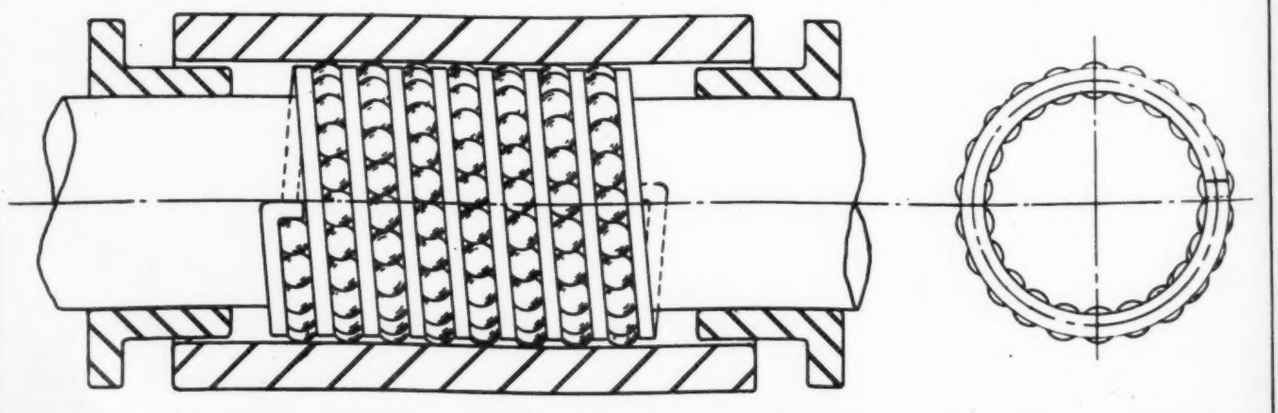
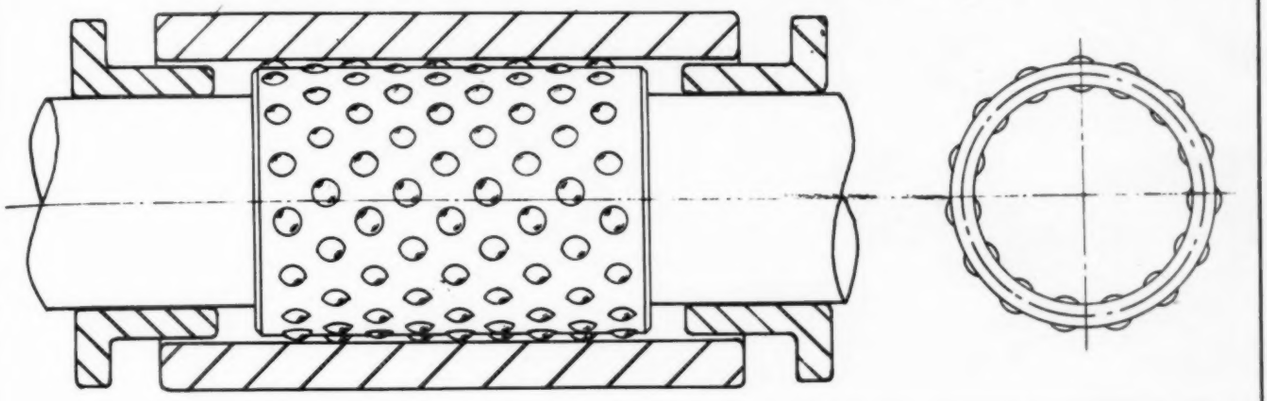


Fig. 2. Conventional type retainer, which necessarily limits the number of balls



(Continued from Page 116)

tion only, the helix of the retainer so positions the balls that each has its own special path.

In one test bearing the helix pitch was 0.250 in. and each row contained twenty-two 3/16-in. dia. balls. Therefore, allowing no end play, each ball had a path (in rotation only) of 0.0113 in. in width. Each path of the stationary race was thus loaded to maximum only once per two revolutions, whereas in a grooved race radial bearing, with 22 balls in line, the maximum load on the stationary race would occur 22 times per two revolutions.

Ball reciprocating bearings are often used to operate in an axial direction only, and in such cases a large number of axial paths exist.

The most common usage of this type of bearing is, of course, in both reciprocation and rotation. Under such usage, the tracks of the numerous balls make intricate and overlapping designs often covering every particle of the surfaces of both raceways. It is desirable to hold diametral clearances close and a slight pre-load is permissible.

Capacity of Bearing

A general guide for the capacity of this type of bearing is as follows: The static capacity is dependent upon the number of balls, the diameter of the balls, and the radius of curvature of the inner race. Expressed in a formula:

$C_s = KND\,F$

Where:

C_s = static capacity,
N = number of balls,
D = ball diameter,
F = curvature factor, and
K = constant = 200.

The constant, K, is derived from laboratory tests of loading balls on hard, flat steel plates up to that point where any greater load would cause brinelling. The value of K is 200 for plates and balls of Rockwell C scale hardness of 60.

The value of the curvature factor, F, is given below. The proper value may be found by determining R, the ratio of the inner race diameter to the ball diameter.

R	4	6	8	10	12	14	16
F	0.820	0.875	0.907	0.930	0.945	0.957	0.965

For values of F, not shown, interpolation may be employed.

For capacity, C_r, in rotation only, the values of C_s may be modified by using K = 100 and applying speed factors as published in Bantam Bearings Division No. 14 Manual. Thus $C_r = 100\,ND^2F$ at 100 r.p.m.

For both rotation and reciprocation, the capacity is little affected by the rate of reciprocation so long as it is not excessive. There are other details that influence the capacity of this type of bearing. Some of them are deflection of parts, accuracy of workmanship, over travel of load, and proper lubrication.

Uses for Bearing

Some of the uses for this type of bearing are as follows:

1. For taper measuring instruments
2. Engine governors
3. Welding machine guides
4. Paper mill doctor blades
5. Printing press vibrator shafts
6. Cloth cutting machines
7. Wheel dresser shafts
8. Spool winding machines
9. Propeller testing equipment
10. Buffing machines
11. Stem grinding and polishing spindles
12. Wire brushing machines
13. Rotary tool pipe cut-off spindles
14. Airplane landing gears
15. Inking rolls
16. Sheet polishing machines
17. Gear grinders and lappers
18. Paper coating machines
19. Remote control gear shift mechanisms
20. Hydraulic welding machines

As the use of this type of bearing has occasionally been limited by its relatively low capacity, its field of usefulness should be greatly increased by this new design, which permits in general of doubling the load-carrying ability of ball reciprocating bearings.

☆ ☆ ☆

Licensing of Seized Patents Liberalized

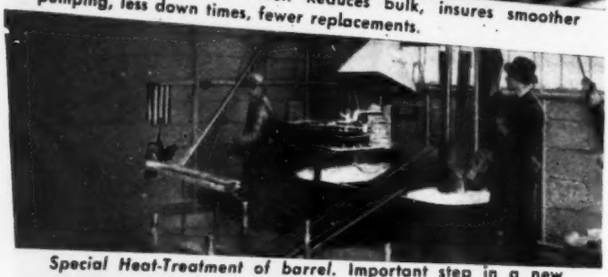
In view of the steadily growing demand for licenses under patents seized from enemy owners, Alien Property Custodian Leo T. Crowley has announced liberalized terms for the issuance of licenses to American business by his office.

Beginning August 1, 1943, the fee for obtaining a license to use enemy owned patents held by the Alien Property Custodian is a flat $15 for each patent. Hitherto, licenses have been issued for a fee of $50 for a single patent plus $5 for each related patent included in the same license.

The new arrangement, Crowley says, will make it easier for small manufacturers to put single patents to work promptly. It also will more equitably compensate the APC for work involved in searching out contractual agreements that already exist on specific patents.

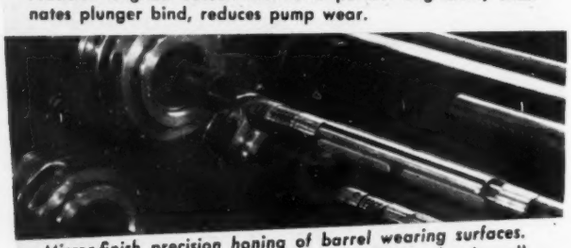
MAINTAIN *Pumping Efficiency* with FLUPACOS

One-piece alloy steel barrel. Reduces bulk, insures smoother pumping, less down times, fewer replacements.



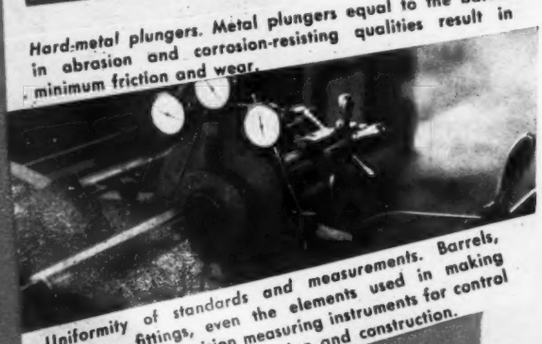
Special Heat-Treatment of barrel. Important step in a new process results in barrels that give 2 to 5 times ordinary wear.

Precision aligned barrel. Maintains perfect alignment, eliminates plunger bind, reduces pump wear.



Mirror-finish precision honing of barrel wearing surfaces. Provides smooth, effortless plunger operation under all conditions.

Hard-metal plungers. Metal plungers equal to the barrel in abrasion and corrosion-resisting qualities result in minimum friction and wear.



Uniformity of standards and measurements. Barrels, plungers, fittings, even the elements used in making them, require precision measuring instruments for control of every detail in pump design and construction.

While the war has placed added obligations on the oil industry and reduced available materials, sound practices in oil well pumping have not been materially affected. Instead, even greater emphasis has been placed on (1) correct pump design and (2) proper pump selection, care during use, and proper maintenance to extend operating life.

Better Pumps From Less Steel

Today, as the result of Fluid Packed Pump Company's long-range development program, oil producers can now secure *better* pumps, made of *less* steel, and still produce *more* oil for the war effort. These new Flupaco pumps are extremely simple and unusually long-wearing, yet they are so efficient that they outperform and undersell conventional types weighing up to four times as much. Some of the more important construction features of these Flupaco pumps include:

FLUPACO'S "PUMPING ANALYSIS"

- SAVES REPAIR TIME
- CUTS OPERATING COSTS
- INSURES LONGER LIFE

Each individual well has its own basic requirements for efficient production. Such pumping factors as the right size of pump for each well...proper installation... pump fit and bore...recommended strokes and speeds...correct valve space and plunger fit . . . are of utmost importance. Consult Flupaco service men for a complete "pumping analysis". This "plus" service can be an invaluable aid in your wartime maintenance program.

Send for a copy of the free booklet "Efficient Oil Well Operation in Wartime".

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P 547.1
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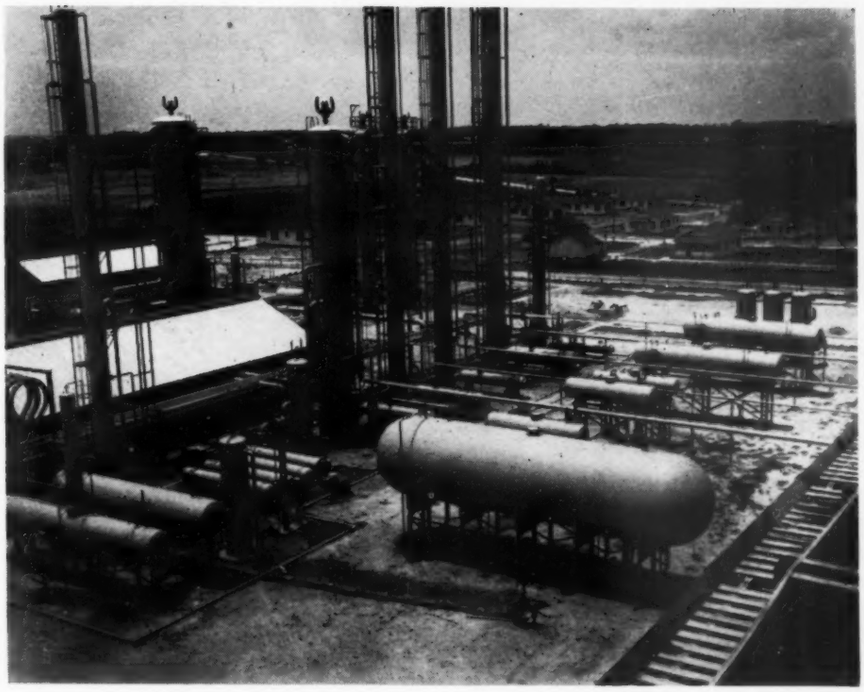


Overhead view of fractionating area with accumulators in foreground and plant residential section in background

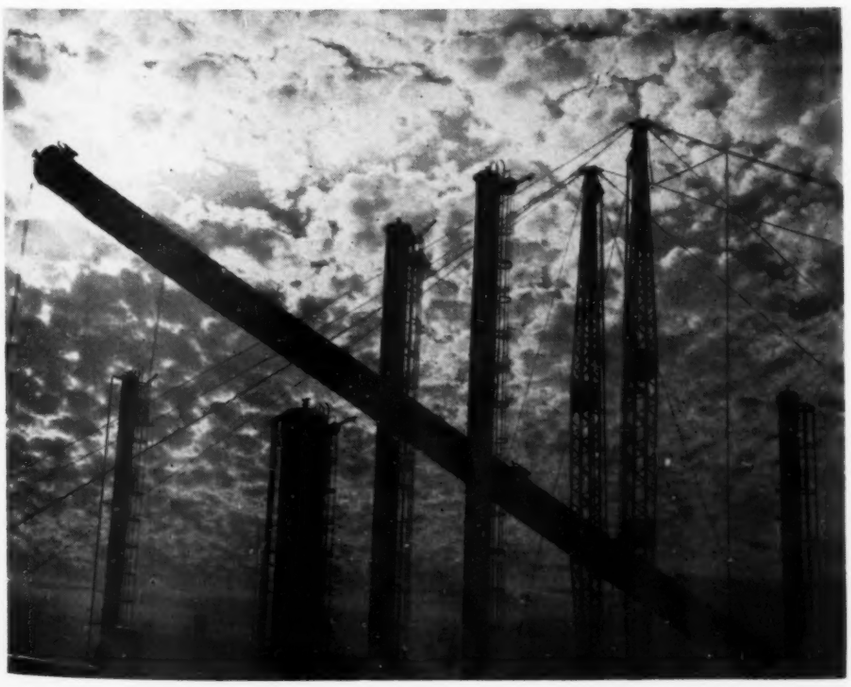
PETROLEUM ENGINEER Exclusive Feature

by
Frank H. Love
Managing Editor

Photographs by J. E. Hampson, Arkansas Natural Gas Companies

Gas Purification and Hydrocarbon Extraction Plant

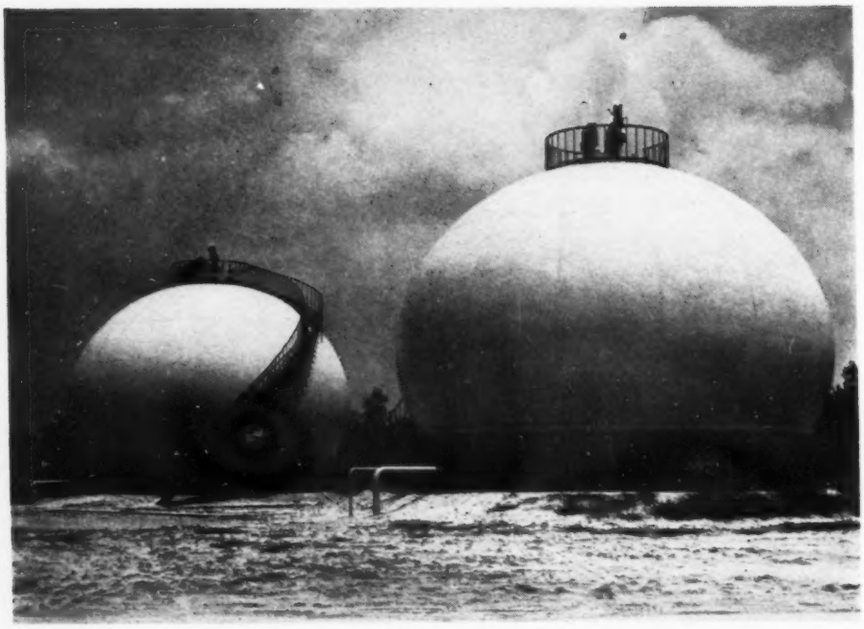
"Sour" gas made available as fuel and for producing components for high-octane gasoline, both an aid to war program



Raising the 145-ft. de-isobutanizer. Special 80-ft. gin poles were required

THE recent completion by Arkansas Fuel Oil Company of the Columbia Gas Treating Plant near Magnolia, Arkansas, has made available as fuel for war and other essential industries a volume of gas that will approximate 81,000,000 cu. ft. daily when full capacity is attained, as well as components for aviation gasoline. At the present time, about 62,500,000 cu. ft. of gas per day is being processed. This gas is produced in the Dorcheat-Macedonia field, a part of which has been useless because of its high content of hydrogen sulphide and carbon dioxide.

The project includes facilities for the purification of "sour" gas produced in the area and for the extraction of condensable hydrocarbons from this gas as well as from "sweet" gas produced by other wells in the field. At full capacity the plant will manufacture approxi-



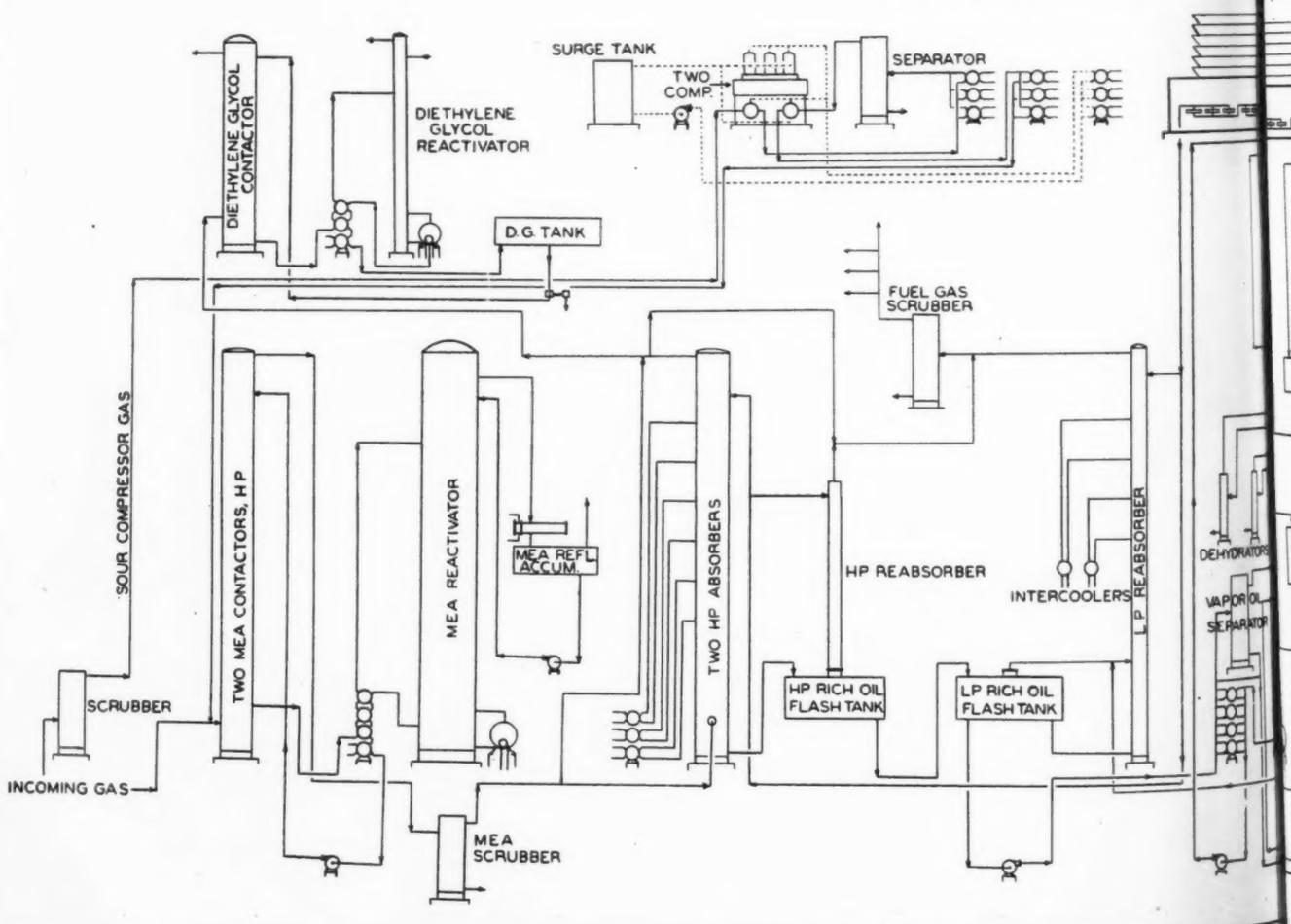
Two of the 5000-bbl. Hortonspheroid tanks for storage of natural gasoline

mately 60,000 gal. a day of liquefied petroleum products, volume of the various products being about as follows: motor fuel, 500,000 gal. a month; normal butane, 300,000 gal. a month; *iso*-butane, 200,000 gal. a month, and propane, 125,000 gal. a month.

The formation from which the "sour" gas is produced is the Smackover limestone, found at a depth of approximately 8700 ft. The area was opened August 28, 1939, by McAlester Fuel Company's No. 1 Lizzie Franks. This was in the Macedonia part of the field, and was followed shortly by completion of Atlantic Refining Company's B-1 Pine Woods in the Cotton Valley sand series of the Dorcheat field, which discovered the first "sweet" gas in the area. This sand series is found from 7000 to 8500 ft. The Dorcheat-Macedonia field has now been extended to approximately 8 miles in length and 2 miles in width. The 25 sour gas wells in the area produce in excess of 1,000,000,000 cu. ft. of gas a month, and the 26 sweet gas wells more than 500,000,000 cu. ft. a month.

Originally reservoir pressure was about 4130 lb., but this has now declined to approximately 3500 lb. Most of the gas-condensate wells have a fluid ratio of about 1 bbl. to 10,000 cu. ft. of gas. Production is gathered in lease tanks and delivered to field gathering lines. The gathering system was laid of

Flow diagram of Arkansas Fuel Oil Comp



pipe ranging from 2 in. to 12 in. in diameter, totaling slightly in excess of 50 miles. Separator pressures range from 600 to 700 lb. and heaters have been installed on most of the leases to raise the temperature of the gas during separation and transportation to prevent formation of hydrates.

Gas Analysis

The following analysis will help to understand the complexity of processing the sour gas:

Component	*Mol., percent*
Hydrogen sulphide	3.1
Carbon dioxide	2.0
Methane	77.1
Ethane	5.8
Propane	2.76
*Iso*butane	1.2
n-butane	1.2
Pentanes	0.82
Hexanes	0.25
Heptanes and heavier	0.07
Nitrogen	5.70
	100.00

This sour gas has a recoverable hydrocarbon content of slightly less than 1 gal. per M. cu. ft. The percentage of hydrogen sulphide present is about 1972 grains per 100 cu. ft. An analysis of the sweet gas is similar to the above except that hydrogen sulphide and carbon dioxide are absent.

Purification Plant

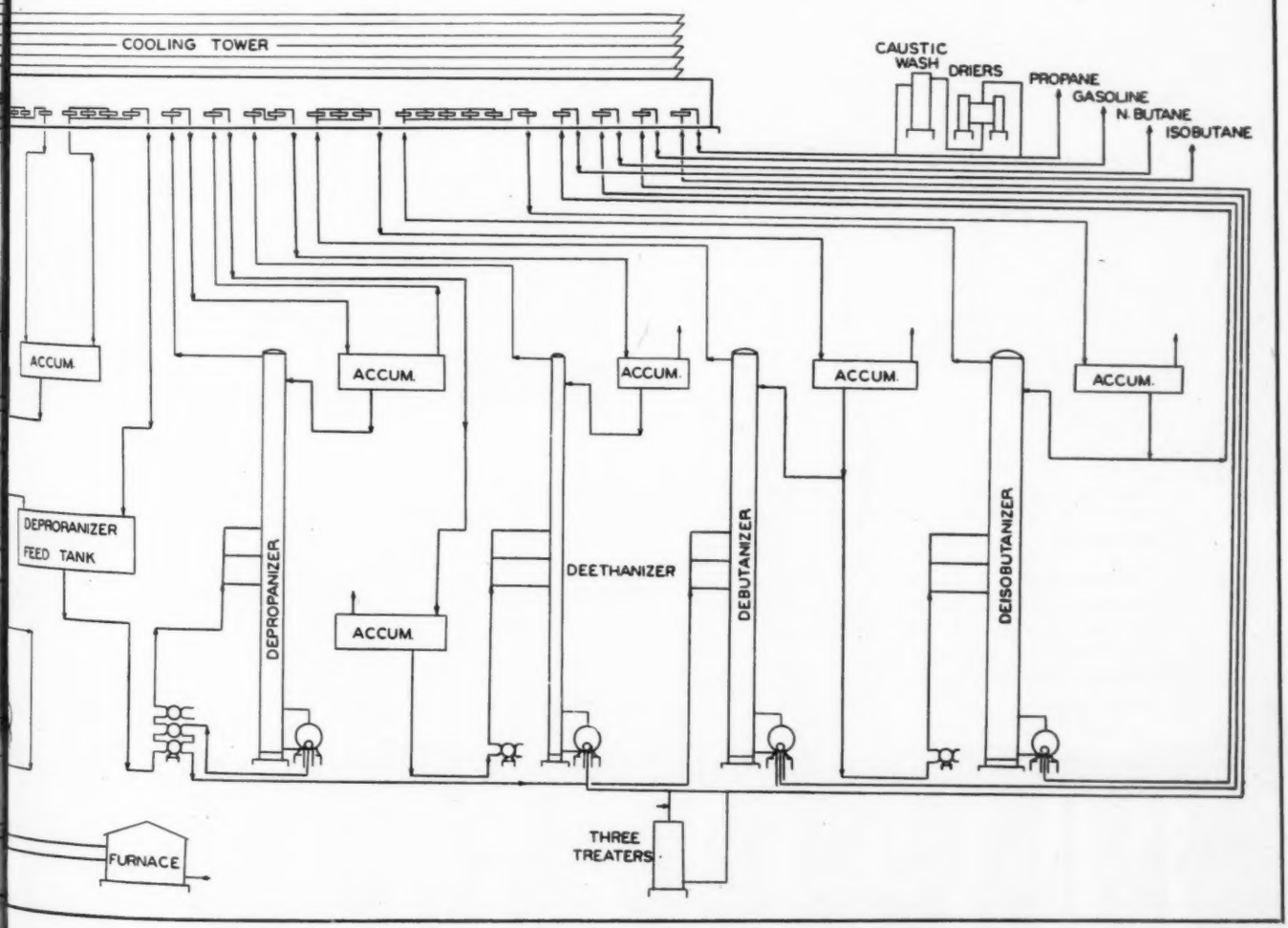
To remove hydrogen sulphide and carbon dioxide in the high concentrations found in the Dorcheat-Macedonia gas presented a complex problem, which was solved by the installation of a Girbotol Process purification unit. Arriving at the plant the sour gas enters two 5½-ft. by 60-ft. monoethanolamine contactors, in the bottom of which is a scrubber section to trap liquids. The contactors, operated at a pressure of 600 lb., are packed with Raschig rings through which the gas passes to contact the solution of monoethanolamine. The enriched solution of monoethanolamine passes through heat transfer units to a 10-ft. by 60-ft. reactivator. The acid gases, consisting of about 60 percent hydrogen sulphide and 40 percent carbon dioxide, are cooled and discharged to a 120-ft. high flare. The lean solution of monoethanolamine, after being reactivated, is cooled and recirculated.

The gas purified by this process meets requirements of the U. S. Bureau of Mines lead acetate test and passes to the absorbers in a stream along with sweet gas, which enters the line at a point between the purification and absorption units. A part of the sweet gas is from low-pressure oil wells and to compress this from a pressure of 50 lb. at which it is received from the field to the absorber pressure of 600 lb., two 300-hp. compressors have been installed. The absorbers consist of two 5-ft. by 114-ft. units, Stripped gas leaves the absorbers to pass through a final dehydrator and enter the transmission system of the Arkansas Louisiana Gas Company. To deliver this gas to consumers a 135-mile pipe line was laid of 12¾-in. and 18-in. pipe.

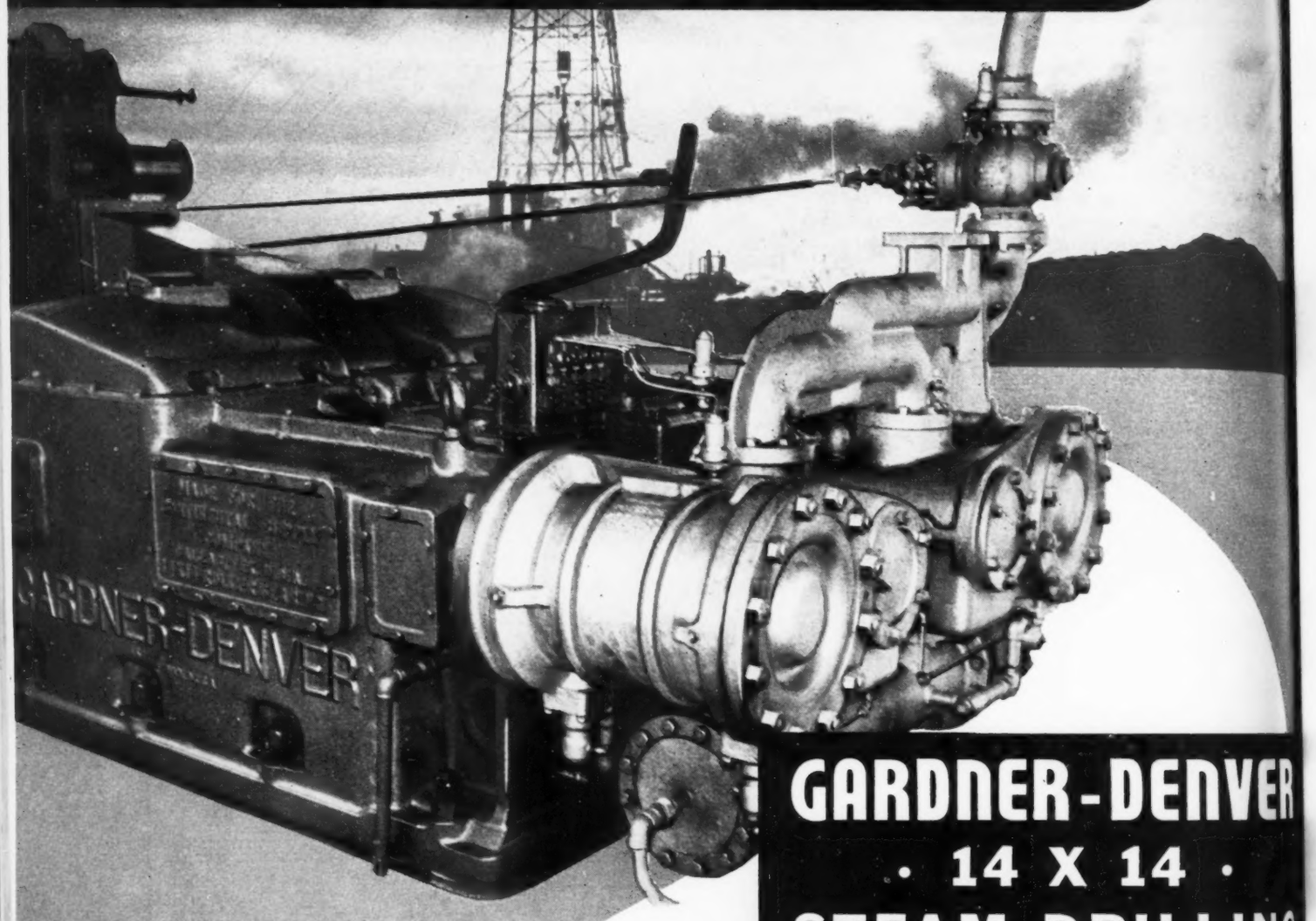
Processing Cycle

From the absorbers the rich oil is pumped through heat transfer units into a radiant-type, direct-fired heater, from which it is charged to a 6-ft. diameter by 58-ft. high combined still and rectifier, operated at a pressure of 100 lb. per sq. in. The rich oil enters the column at a temperature of 475°F. Hydrocarbons condensed in the still-recti-

purification and hydrocarbon extraction plant



SMOOTH FLOWING POWER



GARDNER-DENVER
· 14 X 14 ·
STEAM DRILLING ENGINE

THE GARDNER-DENVER 14 x 14 Steam Drilling Engine easily delivers all the power necessary to operate the heaviest drilling equipment.

This engine is of the piston valve type, with all parts designed and built to withstand continuous pressures of 400 pounds per square inch. Short and direct steam ports give highest possible economy of either saturated or superheated steam.

This GARDNER-DENVER Steam Engine possesses an ample reserve of *smooth flowing power* to meet any contemplated drilling requirement.

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CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

Steam is generated by three 601-hp. water-tube boilers. This photograph was taken while unit was under construction

fier are charged to the depropanizer, which column is 3½ ft. in diameter by 84 ft. high, and is operated at a pressure of 335 lb. per sq. in. Propane is taken overhead and pumped to the deethanizer on which the operating pressure is 550 lb. per sq. in. The bottom product is a 95-percent pure commercial propane. The bottoms from the depropanizer contain natural gasoline, normal butane, and *iso*butane, and these products, after being treated in a Perco solid copper sweetening unit to remove a small amount of mercaptans, are charged to the debutanizer. Operating at a pressure of 100 lb. per sq. in., a 14-lb. natural gasoline is the bottom product, whereas normal butane and *iso*butane are taken overhead and pumped to a 4½-ft. diameter by 145-ft. high de-*iso*butanizer, operated at a pressure of 135 lb. per sq. in. Normal butane comes off the bottom of the column and *iso*butane off the top, both products being 95 percent pure.

Propane production is treated with a caustic wash and dehydrated by means of calcium sulphate in order that it may pass the cobalt bromide moisture test.

Storage

Plant production is stored in two 5000-bbl. Hortonspheroids for natural gasoline, six 1000-bbl. horizontal tanks for *iso*butane and normal butane, and two 500-bbl. tanks for propane. From storage the products are moved by means of tank trucks, tank car, and pipe line.

Steam Plant

Steam is generated by three 601-hp. water-tube boilers operated at 250-lb. pressure. Normal rating of the plant is 90,000 lb. of steam per hour, which is used to drive turbines and reciprocating pumps, and for processing.

Cooling Tower

The cooling tower is of the atmospheric type, 307 ft. long, by 56 ft. high by 25 ft. wide, having a rated capacity of 6000 gal. per min. Three turbine-driven centrifugal pumps, one of which serves as a standby, circulate water from the base over the top of the tower.

Water supply is provided by three wells drilled to a depth of 580 ft. Motor-driven deepwell pumps produce the wells at a rate exceeding 300 gal. per min. each.

Process Pumps

Processing pumps are close-clearance simplex reciprocating steam-driven units.

Laboratory

The laboratory contains the latest testing equipment required by a modern plant of this type, housed in the same structure as the offices of the plant superintendent and his staff.

Personnel and Housing

Operation of the plant requires a staff of about 35 men, which includes operators, firemen, oilers, chemists, meter inspectors, loaders, and guards. To house these men and their families 24 fully-equipped cottages have been constructed.

Contractors

The complete plant, including the gas purification and the hydrocarbon extraction units, was designed and constructed by the Hudson Engineering Corporation of Houston, Texas. Laying of the 135-mile transmission line was by Midwestern Engineering and Construction Company of Tulsa, Oklahoma, and installation of the field gathering lines was contracted to Oldham Brothers Welding and Construction Company of Greggton, Texas.

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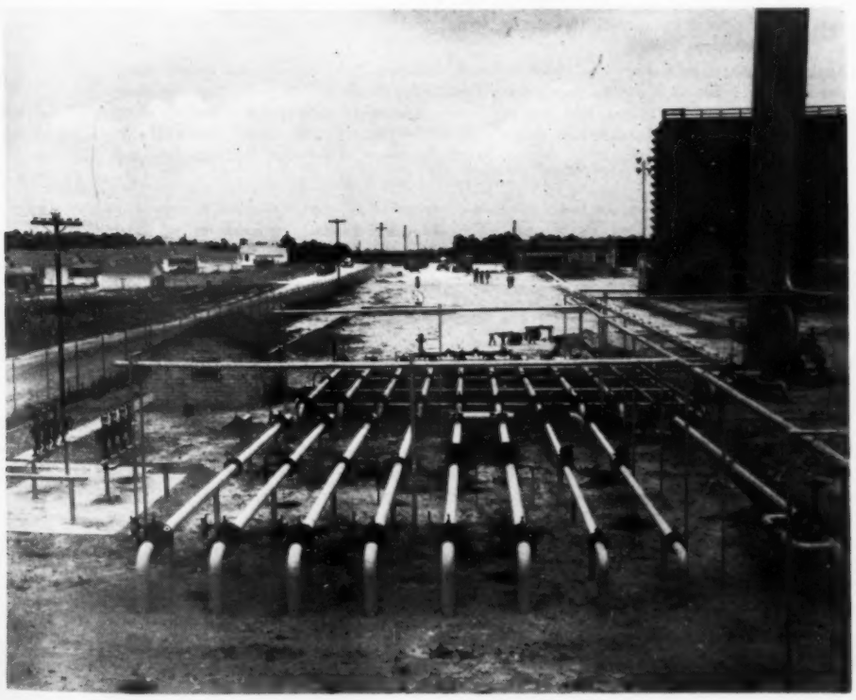


Inlet and outlet gas-measuring station

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

PETROLEUM ENGINEER EDITION

Take a look Inside..

and see why the Baash-Ross Roller Kelly Bushing is built the way it is!

Important Performance Facts on the Industry's Most Famous Bushing

Baash-Ross Roller Kelly Bushings are setting such outstanding performance records wherever they are in service that a constantly increasing number of oil men are asking for more information on the "fine points" of roller bushing design. The following are typical of questions we are frequently asked in the field. Perhaps your question is answered here. If not, our engineering department will be glad to explain to you the engineering "why" of any point you wish to ask about.

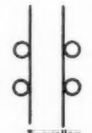
Q Why use *two* rollers in contact with each kelly face? Wouldn't one large roller on each face serve as well?

A. Definitely not. Two rollers give vertical stability to the kelly—prevent it from gyrating and wobbling—hold it steady at *all* table speeds and under *all* drilling conditions, rough or smooth.

One roller on each face would not give this vertical stability . . . would permit the kelly to wobble and gyrate over a wide arc—which, in turn, would not only reduce drilling speed and efficiency, but would also cause severe strains on table bearings, swivel bearings and pipe connections.

Another important point—one roller for each face would necessitate the rollers being quite large in order to prevent "corrugating" the kelly. Large rollers mean high inertia—are slow to start, slow to stop and prevent instant response to kelly feed. But by using *two* rollers against each face, ample driving surface is secured with rollers that are compact, quick-turning, quick-stopping. Result—*instant response to the most delicate bit feed!*

One roller permits wobble



Two rollers maintain alignment

Bronze bushing prevents steel-to-steel contact

Q Why do you use a bronze bushing between each roller and pin? Wouldn't it be easier to simply use larger pins and eliminate the bronze bushings?

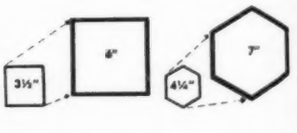
A. It would be easier, yes . . . but not good engineering. The bronze bushings serve a very important function by preventing steel-to-steel contact between rollers and pins. As most engineers know, steel against bronze gives a much better bearing surface than steel-on-steel. It not only resists galling under higher loads, but also carries more efficiently the heavy driving pressures set up between the pins and rollers.

And speaking of the pins, here's another valuable design feature . . . Because there is no pressure (therefore no wear) on the back side of the pins, these have been designed so that they can be easily reversed to bring the unworn back side to the front for additional life after the front sides are worn. Cuts maintenance to a minimum and insures peak performance *longer* without replacements.

Q Do you need a separate Baash-Ross Roller Bushing for each size kelly?

A. No. The same bushing can be quickly changed from one kelly size to another by merely lifting out the roller assemblies—which come in sets—and replacing them with a new set of the desired size. It's simple, fool-proof, *quick* . . . and cuts kelly bushing investment to a minimum.

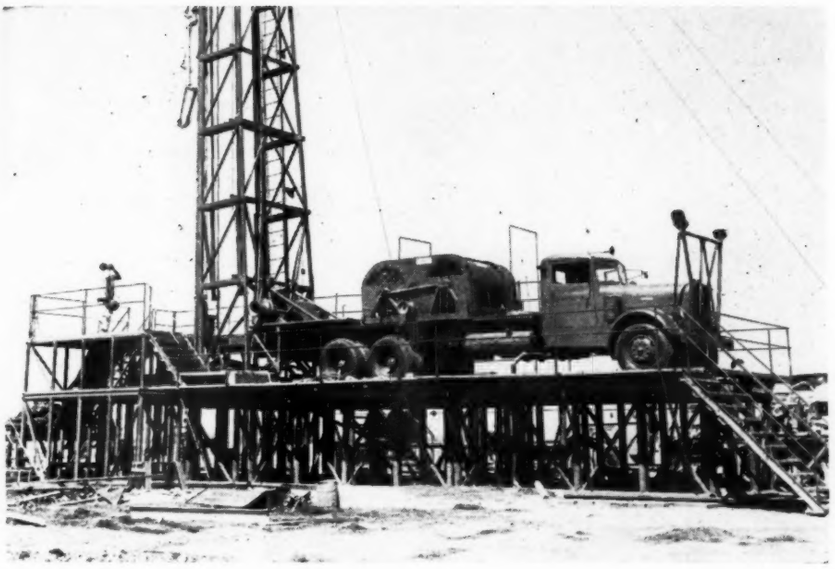
For example, the same Baash-Ross Bushing will fit *all* square kelly sizes from 3½" to 6" by simply changing roller assemblies. Or, when using Hex kellys, the same Roller Bushing will fit all Hex sizes from 4¼" to 7" by changing only the assemblies.



Q It's a well-known fact that close bushing fit is important when using Hex kellys. Can you maintain close fit with the Baash-Ross Roller Bushing for Hex kellys?

A. Absolutely! In fact, the Baash-Ross Hex Roller Kelly Bushing is designed so that all you do to adjust the fit is lift out the roller assemblies and remove one or more shims below each assembly. Working diameter is reduced exactly 1/32" for each shim removed, so it's easy to make accurate adjustment without complicated operations.

Get the complete story on Baash-Ross Roller Kelly Bushing advantages before you invest in any bushing. Your near-by Baash-Ross representative will be glad to supply further details on this modern bushing—or write direct for full information.



Portable drilling equipment showing rear-end rotary countershaft

Petroleum Exclusive

by

Wallace A. Sawdon

Pacific Coast and Foreign Editor

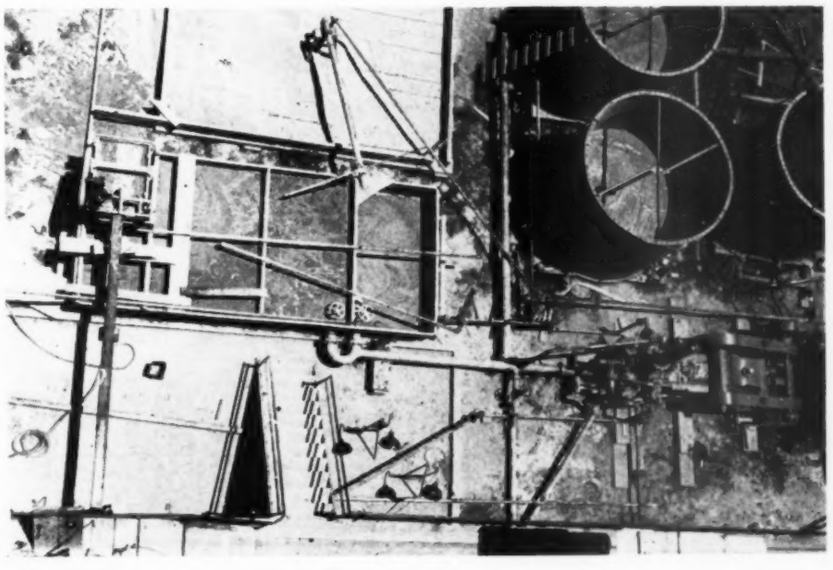
Completing and Repairing Wells With Portable Equipment

☆ Economies effected, especially in connection with completions by selective perforation

EFFECTIVE well completions under certain subsurface conditions frequently require considerable time. This is particularly true when one or more producing horizons contain several oil strata that are separated by formations that may bear water and when selective gun-perforating is utilized to obtain maximum production. Even when careful selection of perforating depths is based on electrical logs, water will sometimes be encountered and a squeeze-cement job followed by perforating will often be necessary.

In one of the most northerly fields of the San Joaquin Valley of California such conditions are encountered and in order to effect greater economy the company operating the field began several months ago to use portable machines for the completion of its wells. The most recently installed portable equipment is shown in accompanying photographs. This rig is a totally portable outfit of the self-propelled type with telescoping derrick that, until put on the well-completion job, was used for servicing other wells in the field. It is now the practice to use the portable machine for completion of drilling wells and when not being so employed to use it for all service and repair work on producing wells, thus eliminating production derricks.

Production in this field has been, until recently, from a sand in the Upper Miocene topped at approximately 5550 ft. and from a Middle Miocene series from 6600 to 6900 ft. The two



Pump, portable mud tank, mud screen, and tank layout. The 7¼ by 10 mud pump is driven by a 150-hp. Diesel engine

Raising the 200,000-lb. capacity, 90-ft. telescoping derrick by means of a power-driven screw mechanism situated beneath the hoist and bed

latest wells also penetrated the Lower Miocene to depths of nearly 8000 ft., the hole actually going below 8000 ft. There is a strong possibility of Eocene production in the field and production from sands in the Eocene will probably be between 8000 and 8500 ft. when this horizon is explored.

The oil sands of the various horizons are thin and are separated by shales that frequently are water bearing. An oil string of 7-in. casing is usually cemented through the sands, being landed either on bottom or from 70 to 80 ft. above bottom when the hole is drilled into the shale below. In some cases the oil string is 5½-in. casing. Gun-perforation for production is based on electrical logs and side-hole coring and in order to obtain maximum production some holes are perforated beyond the sand limits and have to be squeeze cemented. Re-perforation is then necessary. The hole below the shoe of the oil string is not drilled out after cementing operations when drilling is carried into the shale below the sand and is thus effectively plugged off. In one or two earlier wells the oil string was not run through the bottom sand, which was produced through a perforated liner, the sands above being gun-perforated. Present practice, however, is to cement the oil string through all zones and gun-perforate for all production.

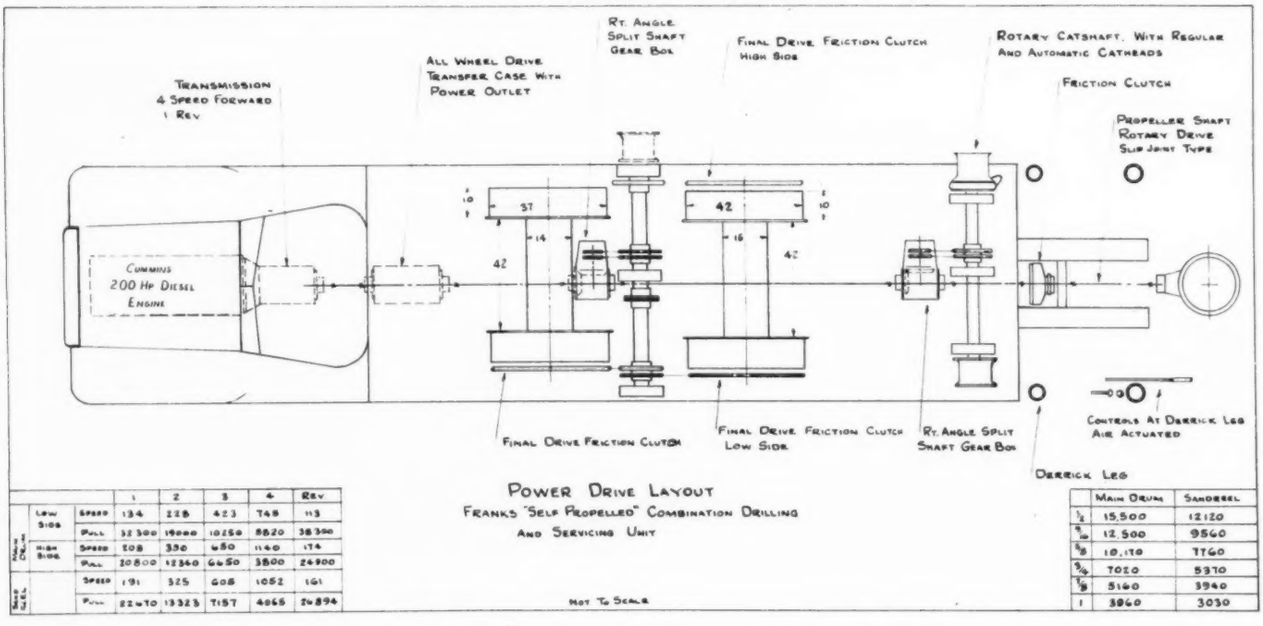
In using the portable machine for completion operations the equipment is moved in as soon as the oil string is run into the hole and before it is cemented. All cementing operations except for the surface pipe, all gun-perforating jobs, and all drilling out of cement is thus done with the portable equipment. This releases the heavy rig, used to drill to the casing seat and run the casing, for other duty and saves crew time during the slower completion operations. Any drilling that may be necessary below the casing shoe will be done with the portable machine.

As can be seen in one of the accompanying photographs, the entire truck-mounted portable equipment being used for the completion of the latest wells is on a substructure that provides room for the blowout preventer and other casinghead equipment. This well was drilled to 8300 ft. and then plugged back to 7915 ft. where 7-in. casing was landed and cemented. At the time the photograph was taken the 2½-in. tubing was about to be run.

Description of Equipment

The portable equipment is a totally self-propelled unit consisting of derrick, hoist, and rotary machine, mounted on a truck with one engine powering both the hoist and rotary table as well as the truck. The truck is specially designed with reinforced frame and dual drive rear axles. As the power pro-

Diagram showing layout of the power drive


Rt. Angle Split Shaft Gear Box
Final Drive Friction Clutch High Side
Rotary Catshaft, With Regular And Automatic Catheads
All Wheel Drive Transfer Case With Power Outlet
Friction Clutch
Transmission 4 Speed Forward 1 Rev
Propeller Shaft Rotary Drive Slip Joint Type
Cummins 200 Hp Diesel Engine
37
42
42
42
Final Drive Friction Clutch
Final Drive Friction Clutch Low Side
Rt. Angle Split Shaft Gear Box
Controls At Derrick Leg Air Actuated
Derrick Leg

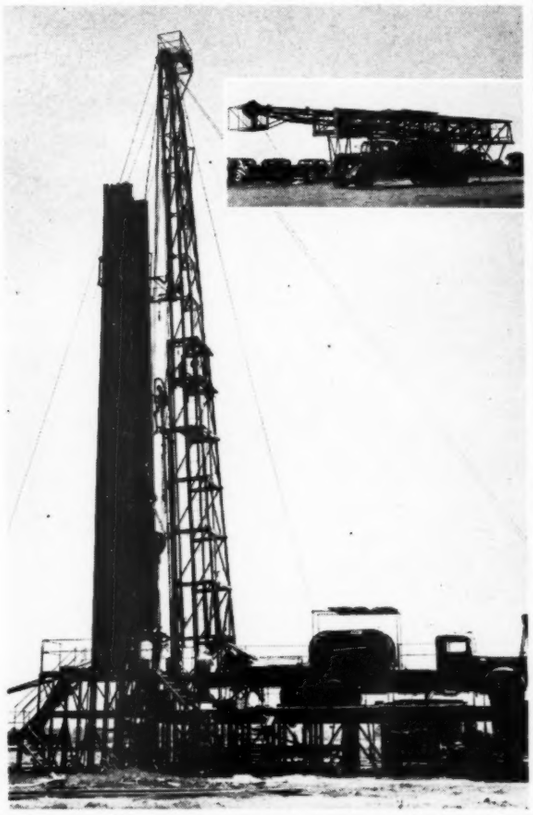
POWER DRIVE LAYOUT
FRANKS "SELF PROPELLED" COMBINATION DRILLING AND SERVICING UNIT

NOT TO SCALE

			1	2	3	4	Rev
Main Drum	Low Side	Speed	134	228	423	748	113
		Pull	32300	19000	10250	5820	38390
	High Side	Speed	208	330	650	1140	174
		Pull	20800	12340	6650	3800	24900
Sand Reel		Speed	191	325	608	1052	161
		Pull	22470	13323	7157	4065	26894

	Main Drum	Sandreel
½	15,500	12120
9/16	12,500	9560
⅝	10,170	7760
¾	7020	5370
⅞	5160	3940
1	3960	3030

COMBINATION DRILLING RIG AND SERVICING UNIT PROVES SUCCESS



7900′ of 2½" tubing racked in the Franks' Model 7000 D.D. "Self-Propelled" Telescoper at Riverdale, California. Sub structure is used only where blow-out preventer is above ground.

Insert shows Franks' Model 7000 D.D. "Self-Propelled" Telescoper in "Over-the-Road" position. The hoist and derrick are mounted on a specially built Kenworth Truck. Hoist and truck are powered by a single HBS-600 200 H.P. Cummins Diesel Engine. Blocks and lines are carried strung at all times.

Raising the 200,000-lb. capacity 90′ telescoping derrick by means of a power-driven screw mechanism, located beneath the hoist and bed.

Actual raising, extending and locking time is less than 10 minutes.

Franks Develops A Double Duty Unit Mounted on Wheels

The first combination 100 percent portable rotary drilling rig and servicing unit is now on the job operating at Riverdale, California.

This unit, made by the Franks Manufacturing Corporation of Tulsa, Oklahoma, contains every essential for either servicing or drilling mounted on a single truck, except the pumps.

SAVES COST OF PERMANENT DERRICK

All of the savings operators have found the world over in Franks portable rotary drilling rigs and telescoping derrick servicing units are found in this double duty combination machine, which even further increases the economies which Franks' pioneering has brought to the petroleum industry.

1. The unit eliminates the cost of permanent derricks since it carries its own. It will service up to 100 wells, eliminating that many derricks per unit.
2. It saves rig-up and tear-down time, since all parts are integrally mounted on wheels and require no assembly or disassembly, except the pumps when drilling.
3. It is 100% portable and is self-propelled, permitting the moving of the derrick as a part of the unit.
4. Carries lines and blocks strung at all times even when moving from location to location.
5. Open-face tilted design derrick permits greater block clearance with more room around the well head or rotary table.
6. Portable derrick can be left standing full of tubing in the field while hoist is used under a standard derrick or with other equipment.
7. Double duty. May be used either as a servicing machine for the deepest wells, or for rotary drilling by the use of the rotary drilling attachment.

A 90-foot (when extended) telescoping derrick (58-foot when telescoped); drawworks, power plant, rotary table, crown block, stacking board and all essentials are an integral part of the unit. The pumps are skid mounted and can be carried on an auxiliary truck, when needed for drilling operations.

The unit will service wells up to 10,000 feet and handle shallow and medium depth standard drilling and deep "slim-hole" and exploratory drilling. It also is used for deepening and cleanout work.

The derrick is Franks tested and proven telescoping type, which permits ample clearance and it is equipped for handling rods and racking tubing or drill pipe.

Move-in and rig-up time for servicing jobs is usually less than 45 minutes, while actual erection time of the derrick requires less than 10 minutes. The complete machine, including the derrick, travels over the road with the blocks and lines strung.

When the unit is used for drilling or deepening purposes a skid mounted separate pump is used as well as a portable mud tank.

The Franks propeller-shaft driven rotary table is driven by the truck motor thru Franks patented power take-off. The truck motor is also used for the drawworks.

A rear-end rotary catshaft is furnished, driven through a bevel gear split-shaft gear box. It is equipped with both automatic and regular catheads located immediately behind the derrick legs.

FRANKS MFG. CORP.
WELL SERVICING AND DRILLING UNITS
Tulsa, U. S. A.

The bureau forecast prepared under the supervision of A. ... chief, Petroleum Economics ... speculation ... increased ... tankers.

"La... ucts ... Coa... ab... do... G... re... con... from the Gulf it would ... ery operations in the East ... increase in the movement of products, particularly fuel oils, from

"Gasoline production," the bureau ... not kept pace with the ... demand and heavy ... gasoline stocks ... district ... dod... compared ... bbl. in ... d ... ies in ... dur... ... July 3 were ... 3,966,000 bbl., respec... ... this period stocks of domestic crude oil declined 138,000 bbl. daily, indicating a demand for

vided to move the complete unit over the road is also used to drive the hoist and rotary table, a supercharged 200-hp. Diesel engine with radiator of sufficient size to permit stationary duty was selected.

The engine is mounted in a conventional position in the chassis and drives through a transmission to a transfer case that routes the power to the rear axles when being transported. A drive diverted through the transfer case provides a power take-off for driving the hoist, and a propeller shaft drive is provided from the transfer case power take-off to a bevel-gear split-shaft gear box that allows the drive to be diverted at right angles or to drive straight through. The right-angle drive then drives the hoist countershaft by means of a chain and sprocket arrangement. The drums are driven from the hoist countershaft by sprockets and roller chain through single plate, two-faced friction clutches mounted in the end of the drum. The drive continuing straight back from the split-shaft bevel-gear box drives the rear-end rotary catshaft through another gear box arrangement of the same type and continues on to drive a propeller shaft-driven rotary table, this drive being under the derrick floor.

The double-drum hoist consists of a main drum and a sand-reel drum driven by friction clutches in the end of each drum. The main drum has a high-low friction clutch drive arrangement, there being a high-sprocket ratio friction clutch drive on one side of the drum and a low-sprocket ratio friction clutch drive on the other. This increases the range of speeds and pulls considerably.

Controls on this particular machine are on the right side of the hoist. These controls actuate the various clutches by air through selector valve assemblies. The brake is manual and the throttle is hydraulic. A starter button and remote gear shift are also provided.

Telescoping Derrick

The derrick is integrally mounted on the unit and is the two-piece, telescoping type. The actual clearance from ground (the floor of the substructure in this particular operation) to the crown beam is 88 ft. When collapsed and in horizontal position on the truck the length is 57 ft. and the overall height above the road is 13 ft. 10 in. The derrick is raised to its vertical position by a power-driven screw mechanism and this is driven from the main propeller shaft drive. Extension of the upper section is accomplished by a small extending winch that is also driven from the main propeller shaft, using a $\frac{5}{8}$-in. wire line anchored in the derrick. The derrick is locked in either high or low position by means of a screw-drive pawl and lug mechanism that is operated from the ground. The derrick in raised position is guyed by four $\frac{3}{4}$-in. wire lines.

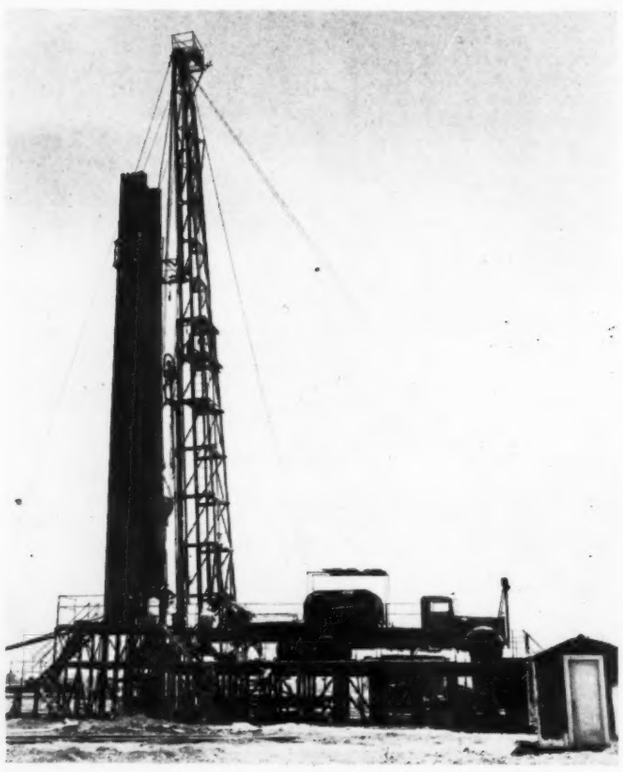
The crown block is welded to the derrick and has four 25-in. O.D. sheaves and one 21-in. O.D. sheave. Three of the larger sheaves are grooved for 1-in. line and the other for $\frac{5}{8}$-in. line. The smaller sheave is grooved for a $1\frac{1}{2}$-in. catline.

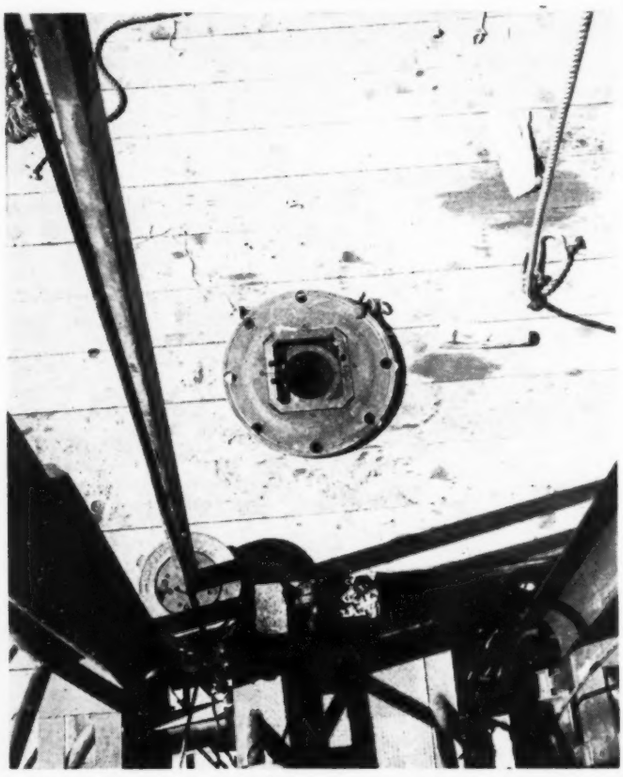
The folding tubing platform has a capacity of 11,000 ft. of $2\frac{1}{2}$-in. tubing or 5000 ft. of $3\frac{1}{2}$-in. drill pipe. The drill pipe being used in this installation for completion of wells from 7000 to 8000 ft. is $2\frac{7}{8}$-in. O.D., flush I.D. The platform is hinged to a sliding track in the upper section of the derrick to allow adjustment through a range of 15 ft. Leveling screws are provided in all four legs.

The pump being used is mounted as a unit with its engine drive and is situated on the ground beside the substructure. It is a $7\frac{1}{4}$-in. by 10-in. pump powered by a 150-hp. Diesel engine. The portable mud tanks, which can be seen in one of the photographs, are 8 ft. by 16 ft. by 4 ft.

☆ ☆ ☆

Left—Racked in the portable drilling rig, on location at Riverdale, California, is 7900 ft. of $2\frac{1}{2}$-in. tubing. Right—Looking down at derrick floor from one of the derrick "stations." The drive for the rotary table is of propeller-shaft type, situated beneath the floor and provides clear working space completely around the table





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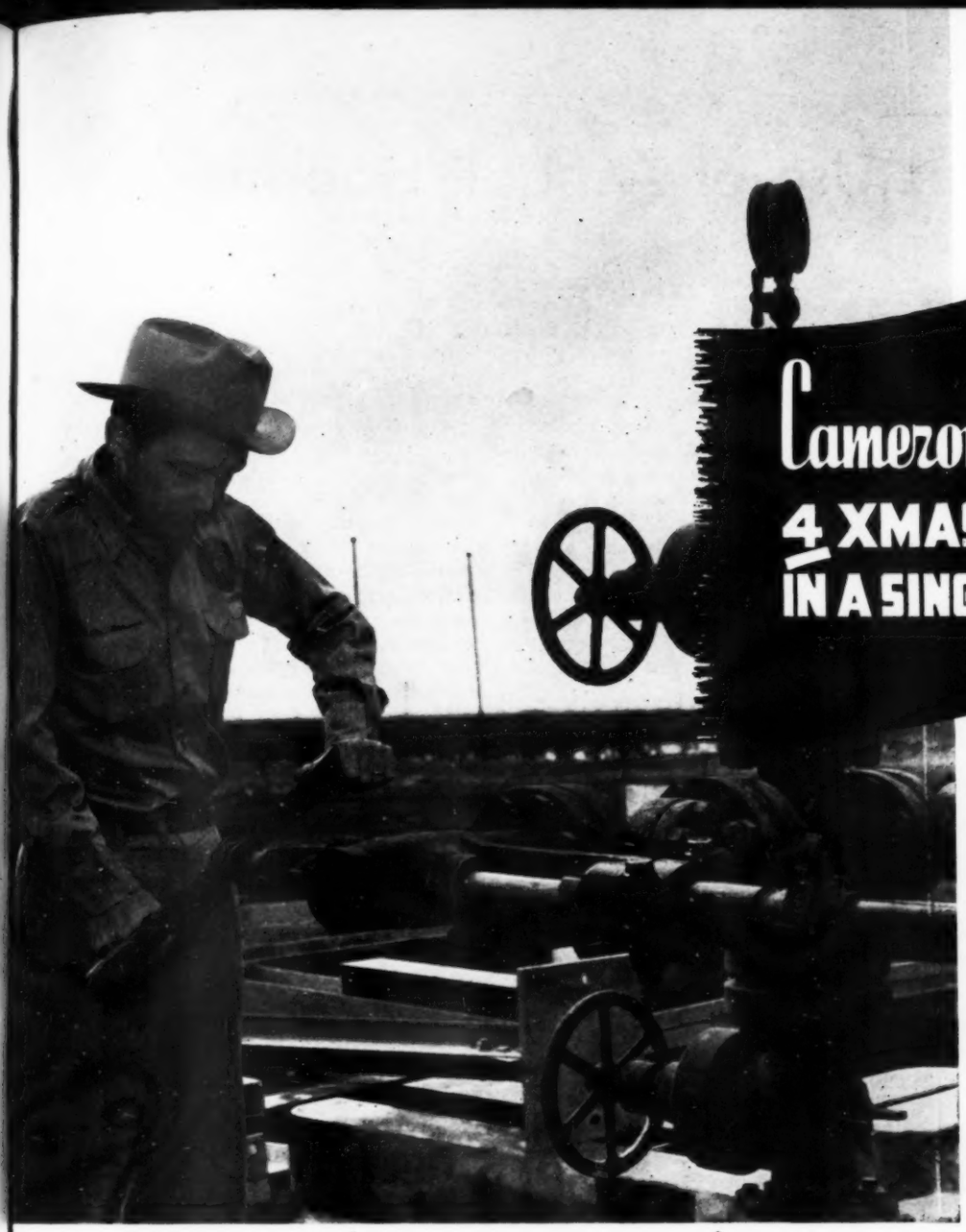
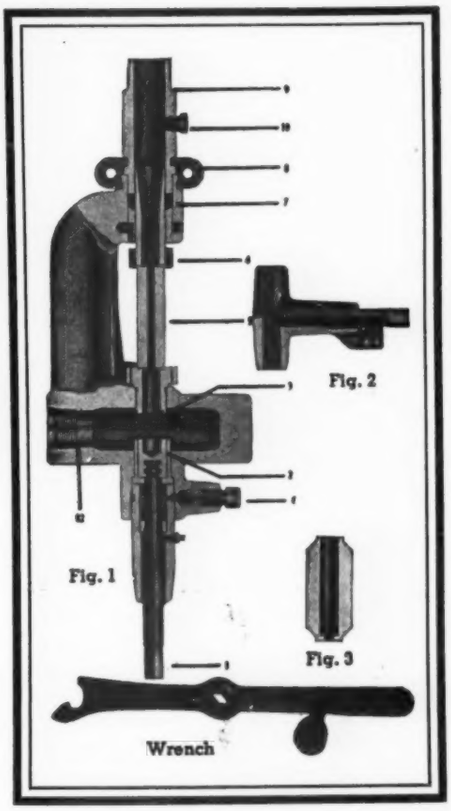


Cameron Flow Wings-

4 XMAS TREE FITTINGS IN A SINGLE COMPACT UNIT



This unique accessory combines four essential Christmas tree fittings in a single compact unit: (1) An efficient wing valve that closes easily under full rated pressure; (2) A quick-change positive or adjustable choke, as desired; (3) An efficient 2-bolt flowline union that obviates the need for an additional union in the flowline; and (4) A bleeder plug to release pressure trapped in the flowline.

Changing flow beans in the Cameron Flow Wing is so simple that it requires only a fraction of the time required by conventional chokes. The valve section operates with surprising ease at full rated pressure. All parts in the assembly may be replaced in the field in a few minutes and at low cost without removing the unit from the well.

Cameron Flow Wings are offered in several screwed and flanged styles, ranging up to 10,000 lb. test. Like any standard fitting or valve, they may be incorporated in any manufacturer's Christmas tree.

Reference to figures above: 1. Valve Stem; 2. Valve; 3. Valve Seat; 4. Clamp Screw; 5. Flow Bean; 6. Packing Feed Screw; 7. Clamp Screw Packing; 8. Two-bolt Union; 9. Outlet Connection; 10. Bleeder Connection; 12. Inlet Connection.

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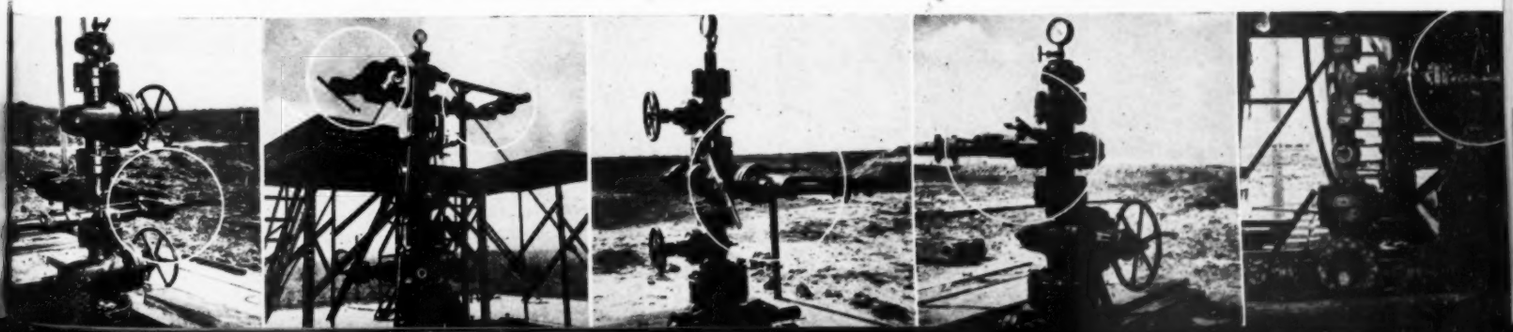


War Increases Use of Asphalt Flooring

PETROLEUM ENGINEER Exclusive Feature

by H. K. Sharp

Manager, Asphalt Specialties Dept., The Philip Carey Mfg. Co.

NECESSARY restrictions on structural steel and concrete reinforcing steel are tending to develop an increased interest in heavy timber construction. Obviously, every effort is being made through improved design and planning to take full advantage of the available supply of lumber.

One problem arising from this greater volume of heavy wood construction is that of providing traffic surfaces to meet specific needs for various conditions encountered in the industrial and transportation fields. A satisfactory solution is found in many instances by using Elastite Asphalt Flooring. This product is a composition of high melting point asphalt, with mineral and fiber reinforcement, formed into tough slabs ½ in. thick for general inside usage, or planks up to 2 in. thick for surfacing bridge floors and for protection of waterproofing membranes. Used extensively for many years over new and old floors, this type of flooring fits naturally into the accelerated war construction program because of ease in handling and results obtained.

The ½-in. flooring or tile can be cemented directly to the wooden subfloor with asphaltic adhesive and the greater thicknesses of plank can be cemented or nailed to the sub-floor. Once in place, this asphaltic composition floor material provides a tough and durable surface that also has a tendency to remain resilient under traffic. Unusually severe surface damage can be easily repaired by merely replacing the damaged units before any harm is done to the structural sub-floor. This can be handled quickly and easily, thus helping to reduce maintenance costs and avoiding production tie-ups.

The flooring does not "dust" under traffic, thus providing a more permanent surface and one that is comparatively easy to keep clean. This feature is important to many modern industries when the presence of much dust would be harmful to the finished products.

Another feature of asphaltic composition flooring is its resistance to moisture, as this material has a very low water absorption value. This means that an average installation with cemented joints would keep surface moisture from the wooden sub-floor and that a waterproof and rot-proof surface can be made by adding a suitable membrane underneath the asphalt flooring. This same type of construction will protect wooden sub-floors from action of some dilute acids used in industry that would ordinarily be harmful, but which will not affect the asphalt. For industries where it is desirable to wash floors or where moisture is present because of necessary processing, the water-resisting surface as provided by the asphalt flooring is essential for protection of wooden sub-floors and also the structural members.

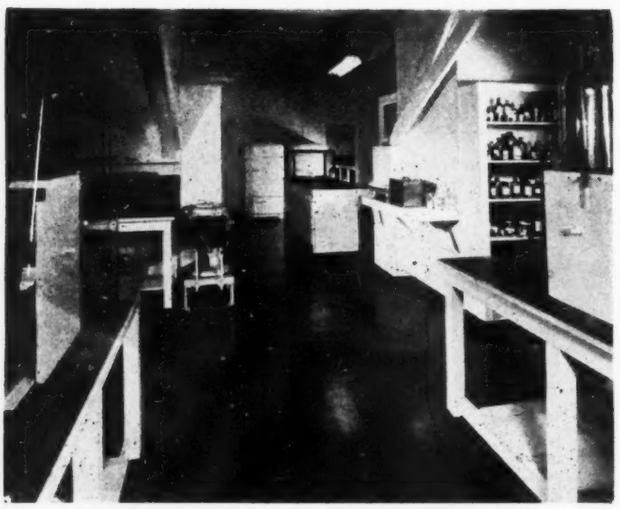
Asphaltic composition flooring is fire-resistant thus affording protection as well as service. It has a flash point of approximately 700°F. and does not have a tendency to support combustion. In case of fire, of course, the waterproofing features previously mentioned are especially helpful in reducing water damage, from sprinklers or fire hose, to floors below. The flooring also has comparatively high di-electric strength, with an average breakdown voltage of 30,000 volts for the ½-in. material, making it safe in this respect for use around switchboards or in power plants.

Elastite Asphalt Tile in the ½ in. thickness can be obtained in red or black pieces, with a smooth surface that can be waxed. Thus the advantages of durability and protection are made available for use on office or similar floors.

In addition to the aforementioned features, the flooring material also provides a comfortable surface for walking or standing and a surface that will hold up under loads in excess of 2000 lb.

The problem of specialized flooring is just one of the many involved in adapting wood construction to some of today's various industries; but the answer is readily found in most instances by using accessory construction materials that have already been tried and proved. ☆☆☆

Asphalt tile flooring was used in the scientific laboratory (left) and the oil company shipping warehouse (right) shown below



THE *Petroleum* Engineer's CONTINUOUS TABLES

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INSTALLMENT NO. 74

A VALUABLE and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously. More than 450 tables have been published.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

To readers of *The Petroleum Engineer,* who are only now becoming interested in the Continuous Tables, it should be pointed out that each table is assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum and related industries by L. C. Uren, professor of Petroleum Engineering at the University of California. This complete index has been published in earlier installments of the tables and is now available in booklet form at a cost of 50 cents per copy from *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas. Complete sets of the tables from the first installment to the present are also available in conjunction with subscriptions at the rate of $3.00 a year, or $4.00 for two years. General field classification numbers are as follows:

Nos. P000-P399—General

Nos. P400-P-499—Drilling

Nos. P500-P599—Production

Nos. P600-P699—Transportation and storage (includes pipe line)

Nos. P700-P799—Refining, including

Nos. P770-P799—Natural Gasoline, which may be classified in a separate division as shown here if of special interest to the user

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VAPORIZATION EQUILIBRIUM CONSTANTS FOR NORMAL HEXANE

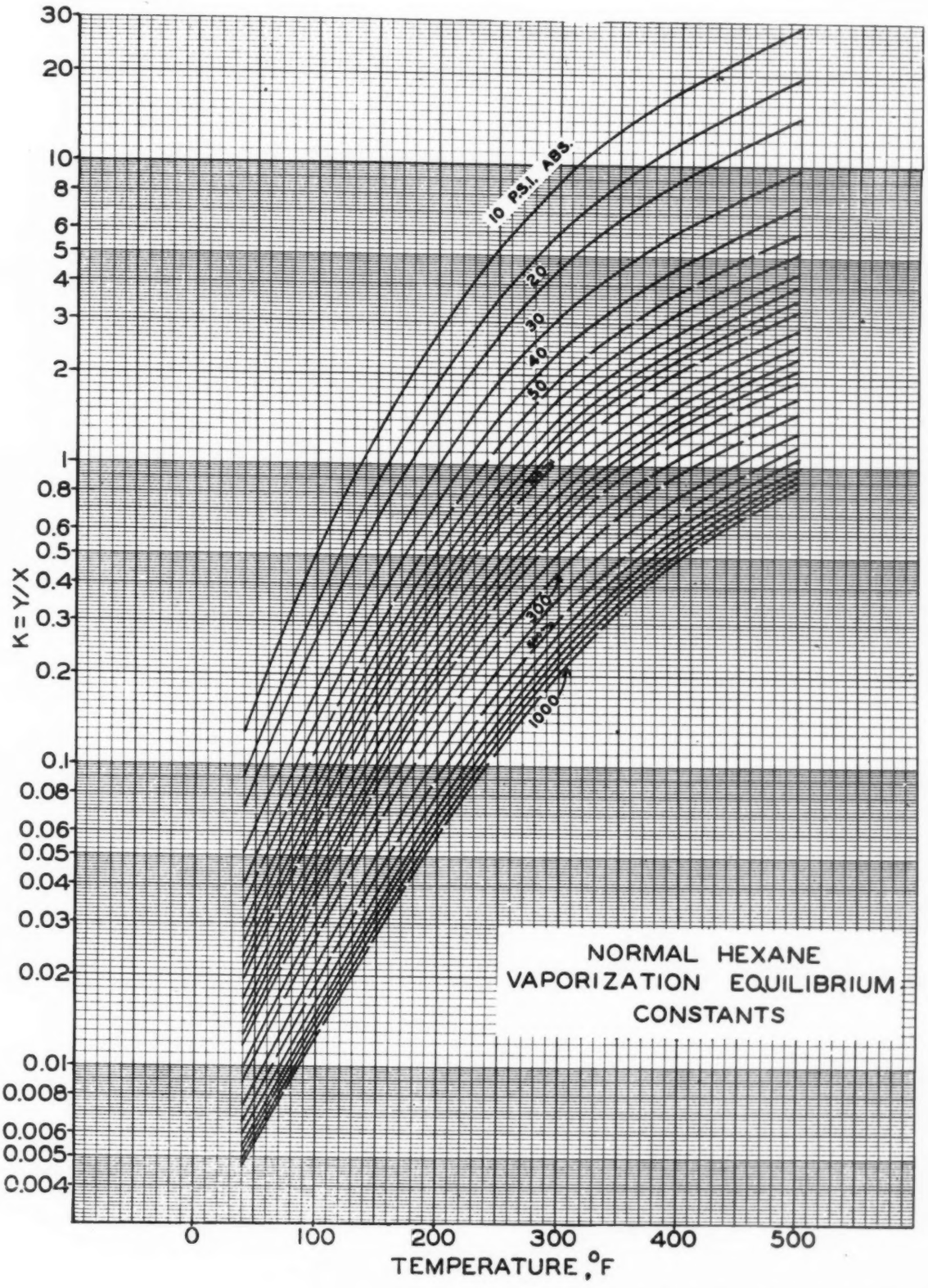

Chart by George Granger Brown, University of Michigan.

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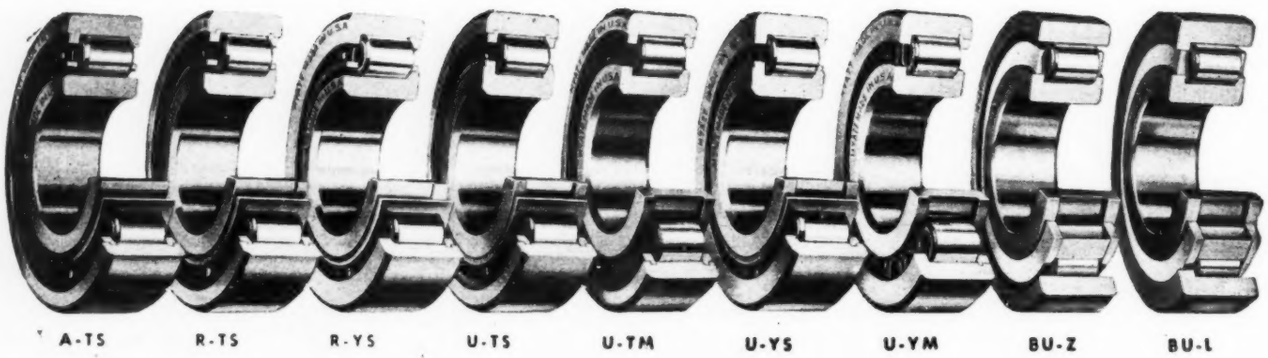

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In light and medium series, narrow and wide widths. Made to American Standards Association boundary dimensions—and to Hyatt standards of quality. The check list below shows how Hyatt Hy-Loads can solve radial bearing problems for you. For further information, write for Bulletin 541A.

A-TS For shafts of fixed location, carrying torsional and radial loads only.

R-TS Same as above, but with one flange on the inner race.

R-YS Where bearing is required to take light or intermittent thrust loads and locate the shaft in one direction. Has flange on inner and outer race.

U-TS Where application has no provision to retain the outer race endwise, or where bearing must be assembled as a unit.

U-TM For additional capacity on slow speed applications. Similar to U-TS, but separator is omitted to allow maximum number of rollers.

U-YS When bearing must be assembled as a complete unit, and sustain light thrust or locate shaft in one direction.

U-YM For additional capacity on slow speed applications. Similar to U-YS, but separator is omitted to allow maximum number of rollers.

BU-Z Where mounting conditions require that the roller and inner race assembly be kept with the shaft.

BU-L Where bearing must also locate the shaft or sustain light thrust loads in one direction.

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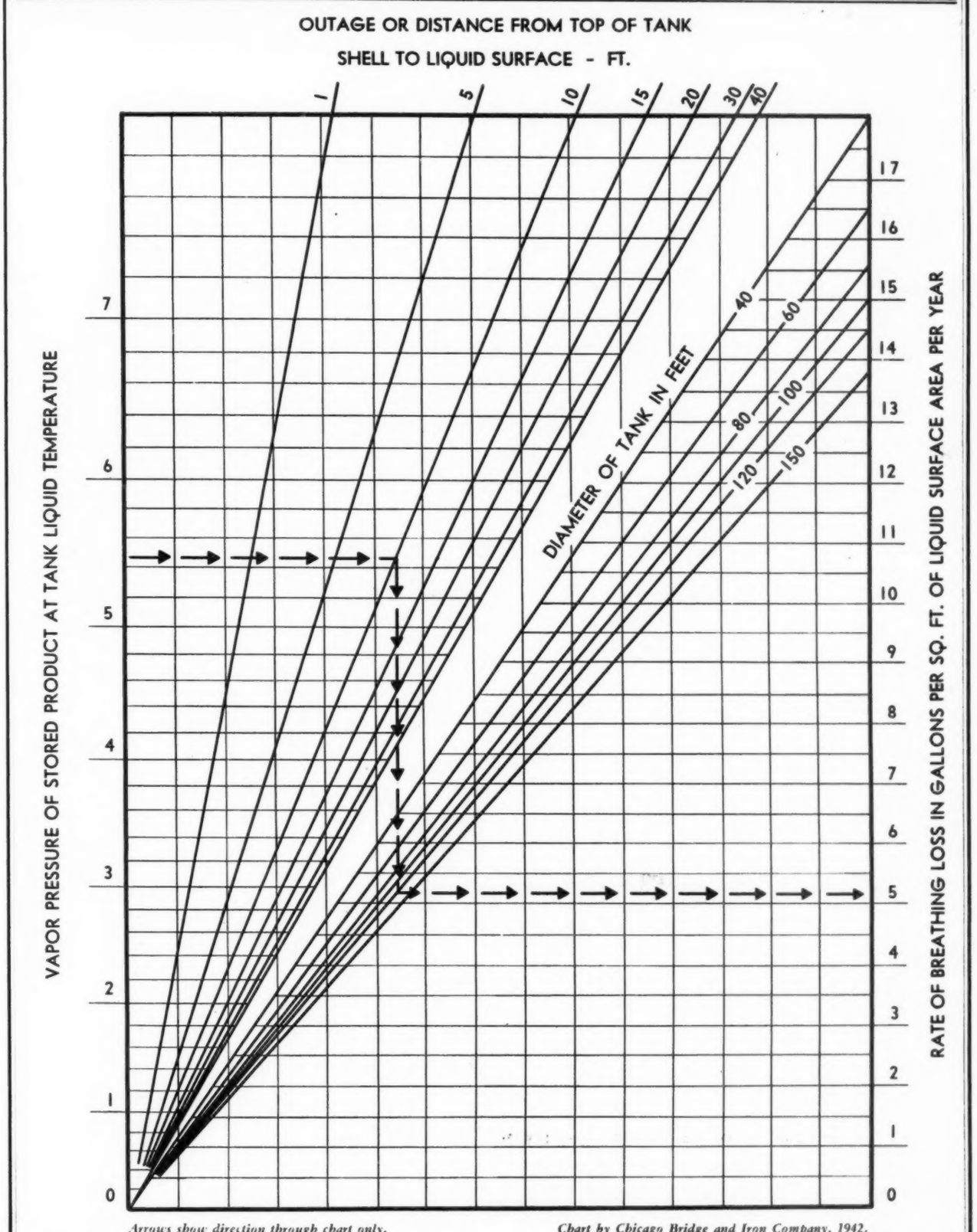
HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, N. J.

BREATHING LOSS FROM CONE ROOF TANKS WITH CONSERVATION VENTS



Arrows show direction through chart only.

Chart by Chicago Bridge and Iron Company, 1942.

The above chart provides a simple and direct means for estimating the average rate of breathing loss from a light colored storage tank having a fixed steel roof equipped with conservation vent valves. The rate of loss indicated by the chart varies with the vapor pressure of the stored liquid, the volume of the vapor space and the size of the tank. Several oil companies have developed methods for estimating breathing losses based on the results of extensive evaporation tests. The curves in the above chart were plotted from data secured by averaging results calculated by the estimating methods of three oil companies and one tank manufacturer.

Example: Determine the rate of breathing loss from an 80,000-bbl. cone roof storage tank under the following storage conditions: tank dimensions, 120 ft. diam. x 40 ft.; area of liquid surface, 11,300 sq. ft.; product stored, 10 lb. R.V.P. gasoline; average liquid temperature, 60°F., and average outage, 20 ft.

Referring first to Table P 640.1 the true vapor pressure of a 10-lb. R.V.P. motor gasoline at a liquid temperature of 60°F. is 5.2 lb. per sq. in. abs.

Enter the chart above from the left at 5.2 lb., and move horizontally to 20 ft. outage, then downward to 120 ft. tank diameter, and then horizontally to the right. The rate of breathing loss is found to be 6.2 gal. per sq. ft. of liquid surface area per year.

Total breathing loss = 11,300 x 6.2 = 70,000 gal. per year.

1st Birthday of the M-7
It's the "tank-killer" that helped turn the tide at El Alamein...and the British 8th Army and a whale of a lot of Americans deserve credit for what it did!
TO THE FOLLOWING GOES FULL CREDIT FOR THE AMAZING JOB THE M-7 HAS DONE:
American Locomotive Company
SUBCONTRACTORS, SUPPLIERS AND OTHERS WHO HELPED IN THE BUILDING OF THE M-7
American Brass Co., New York
American Brake Shoe & Fdy. Co., American Manganese Steel Div. Chicago Heights, Ill.
American Can Co., New York
American Car & Fdy. Co., New York
American Chain & Cable Co., N. Y.
American Chain Div.
Hazard Wire Rope Div.
American Felt Co., Glenville, Conn.
Thank you

Our congratulations to American Locomotive for this inspiring message. Our thanks to you for including Hazard Wire Rope Division among those who helped build the "tank-killer." • In your list of 445 manufacturers we found 136 who use Hazard Wire Rope in their product, in their plants, or both. • Such interchange of industrial products, such mutual help in times of difficulty, will help win the war, will help win the peace, as it has done from our country's earliest years.

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Distributors in all important oil field centers

AMERICAN CHAIN & CABLE COMPANY, INC. • **BRIDGEPORT, CONNECTICUT**

HAZARD LAY-SET Preformed ROTARY LINES

PROPERTIES OF ROUND WELDED CARBON STEEL TUBES

Outside diameter, in.		Wall thickness B.W.G. & dec. in.	Inside diameter, in.	Section area, sq. in.	Weight lb. per ft.	Inside surface per lineal ft.		Lineal ft. per sq. ft. inside surface	Outside surface per lineal ft.		Lineal ft. per sq. ft. outside surface	Inside volume per lineal ft.			Lineal ft. per cu. ft. volume	Transverse area sq. in.	Displacement per lineal ft.		
						sq. in.	sq. ft.		sq. in.	sq. ft.		cu. in.	cu. ft.	gal.			cu. in.	cu. ft.	gal.
1⅞	x	16(0.065)	1.745	0.3696	1.257	65.79	0.4568	2.189	70.69	0.4909	2.037	28.699	0.0166	0.1242	60.24	2.761	33.134	0.0912	0.1436
	x	14(0.083)	1.709	0.4672	1.589	64.43	0.4474	2.235				27.527	0.0159	0.1191	62.89				
	x	13(0.095)	1.685	0.5312	1.806	63.52	0.4411	2.267				26.760	0.0155	0.1158	64.50				
	x	12(0.109)	1.657	0.6048	2.056	62.47	0.4338	2.305				25.877	0.0150	0.1120	66.66				
	x	11(0.120)	1.635	0.6616	2.249	61.64	0.4280	2.336				25.195	0.0146	0.1990	68.49				
	z	10(0.134)	1.607	0.7329	2.492	50.48	0.4207	2.377				24.339	0.0141	0.1053	70.94				
2	x	16(0.065)	1.870	0.3951	1.343	70.50	0.4896	2.042	75.40	0.5236	1.910	32.958	0.0191	0.1426	52.36	3.142	37.699	0.0218	0.1631
	x	14(0.083)	1.834	0.4999	1.699	60.14	0.4801	2.083				31.701	0.0183	0.1372	54.64				
	x	13(0.095)	1.810	0.5686	1.933	68.24	0.4739	2.110				30.876	0.0179	0.1337	55.87				
	x	12(0.109)	1.782	0.6476	2.201	67.18	0.4665	2.144				29.929	0.0173	0.1295	57.80				
	x	11(0.120)	1.760	0.7087	2.409	66.35	0.4608	2.170				29.194	0.0169	0.1263	59.17				
	z	10(0.134)	1.732	0.7854	2.671	65.30	0.4534	2.206				28.273	0.0164	0.1223	60.98				
2⅛	x	16(0.065)	1.995	0.4207	1.430	75.21	0.5223	1.915	80.11	0.5563	1.798	37.511	0.0217	0.1624	46.08	3.547	42.559	0.0246	0.1840
	x	14(0.083)	1.959	0.5324	1.810	73.83	0.5129	1.950				26.169	0.0209	0.1565	47.85				
	x	13(0.095)	1.935	0.6059	2.060	72.95	0.5066	1.974				35.289	0.0204	0.1527	49.02				
	z	12(0.109)	1.907	0.6904	2.347	71.89	0.4993	2.003				34.275	0.0198	0.1484	50.50				
	z	11(0.120)	1.885	0.7559	2.570	71.06	0.4935	2.026				33.329	0.0193	0.1443	51.81				
	z	10(0.134)	1.857	0.8382	2.848	70.01	0.4862	2.057				32.417	0.0188	0.1403	53.19				
	z	9(0.148)	1.829	0.9192	3.125	68.95	0.4788	2.089				31.528	0.0182	0.1365	54.94				
2¼	x	16(0.065)	2.120	0.4464	1.517	79.92	0.5550	1.802	84.82	0.5891	1.697	42.359	0.0245	0.1833	40.82	3.976	47.713	0.0276	0.2064
	x	14(0.083)	2.084	0.5651	1.921	78.57	0.5456	1.833				40.933	0.0237	0.1772	42.19				
	x	13(0.095)	2.060	0.6432	2.186	77.66	0.5393	1.854				39.995	0.0231	0.1731	43.29				
	x	12(0.109)	2.032	0.7331	2.492	76.60	0.5320	1.880				38.915	0.0225	0.1684	44.44				
	x	11(0.120)	2.010	0.8030	2.730	75.78	0.5262	1.900				38.077	0.0220	0.1648	45.45				
	z	10(0.134)	1.982	0.8906	3.028	74.72	0.5189	2.927				37.024	0.0214	0.1602	46.73				
	z	9(0.148)	1.954	0.9774	3.323	73.66	0.5116	1.955				35.985	0.0208	0.1557	48.08				
2⅜	x	16(0.065)	2.245	0.4717	1.604	84.63	0.5877	1.702	89.54	0.6218	1.608	47.501	0.0277	0.2072	36.10	4.430	53.161	0.0308	0.2304
	x	14(0.083)	2.209	0.5976	2.032	83.28	0.5783	1.729				46.190	0.0266	0.0991	37.60				
	x	13(0.095)	2.185	0.6805	2.313	82.37	0.5720	1.748				44.996	0.0260	0.1947	38.46				
	x	12(0.109)	2.157	0.7760	2.638	81.32	0.5647	1.770				43.850	0.0254	0.1898	39.37				
	x	11(0.120)	2.135	0.8501	2.890	80.49	0.5589	1.789				42.954	0.0248	0.1859	40.32				
	z	10(0.134)	2.107	0.9434	3.207	79.43	0.5516	1.813				41.841	0.0242	0.1811	41.32				
	z	9(0.148)	2.079	1.0355	3.520	78.38	0.5443	1.837				40.736	0.0236	0.1763	42.37				
2½	x	16(0.065)	2.370	0.4972	1.690	89.35	0.6204	1.612	94.25	0.6545	1.528	52.938	0.0306	0.2291	32.68				
	x	14(0.083)	2.334	0.6302	2.143	87.99	0.6110	1.637				51.342	0.0297	0.2222	33.67	4.909	58.905	0.0341	0.2550
	x	13(0.095)	2.310	0.7178	2.440	87.09	0.6048	1.653				50.292	0.0291	0.2176	34.36				
	x	12(0.109)	2.282	0.8188	2.783	86.03	0.5974	1.674				49.180	0.0284	0.2124	35.21				
	x	11(0.120)	2.260	0.8972	3.050	85.20	0.5917	1.690				41.838	0.0279	0.2083	35.97				
	z	10(0.134)	2.232	0.9960	3.386	84.15	0.5843	1.711				46.953	0.0272	0.2032	36.76				
	z	9(0.148)	2.204	1.0935	3.718	83.09	0.5770	1.733				45.782	0.0265	0.1982	37.74				
2⅝	x	16(0.065)	2.495	0.5228	1.777	94.06	0.6532	1.531	98.96	0.6873	1.455	57.830	0.0340	0.2542	29.41	5.412	64.943	0.0376	0.2812
	x	14(0.083)	2.459	0.6628	2.253	92.70	0.6438	1.553				56.989	.0330	0.2467	30.30				
	x	13(0.095)	2.435	0.7551	2.567	91.80	0.6375	1.569				55.812	0.3230	0.2419	30.96				
	x	12(0.109)	2.407	0.8616	2.929	90.74	0.6302	1.587				54.604	0.0316	0.2363	31.65				
	x	11(0.120)	2.385	0.9444	3.210	89.91	0.6244	1.602				53.610	0.0310	0.2320	32.26				
	z	10(0.134)	2.357	1.0487	3.565	88.86	0.6171	1.620				52.359	0.0303	0.2266	33.00				
	z	9(0.148)	2.329	1.1517	3.915	87.80	0.6097	1.640				51.122	0.0292	0.2185	34.25				
2¾	x	16(0.065)	2.620	0.5482	1.864	98.77	0.6959	1.458	103.67	0.7200	1.389	64.695	0.0374	0.2800	26.74	5.940	71.275	0.0412	0.3082
	x	14(0.083)	2.584	0.6954	2.364	94.71	0.6765	1.478				62.930	0.0364	0.2724	27.47				
	x	13(0.095)	2.560	0.7924	2.694	96.51	0.6702	1.492				61.766	0.0357	0.2674	28.01				
	x	12(0.109)	2.532	0.9044	3.074	95.45	0.6629	1.509				60.423	0.0350	0.2615	28.57				
	x	11(0.120)	2.510	0.9915	3.371	94.62	0.6571	1.522				59.377	0.0344	0.2570	29.07				
	z	10(0.134)	2.482	1.1013	3.744	93.57	0.6498	1.539				58.054	0.0336	0.2513	29.76				
	z	9(0.148)	2.454	1.2098	4.113	92.51	0.6425	1.556				56.752	0.0328	0.2456	30.49				
2⅞	x	16(0.065)	2.745	0.5738	1.951	103.48	0.7186	1.392	108.38	0.7527	1.329	70.016	0.0411	0.3074	24.33	6.497	77.902	0.0451	0.3373
	x	14(0.083)	2.709	0.7280	2.475	102.12	0.7093	1.410				69.166	0.0400	0.2994	25.00				
	x	13(0.095)	2.685	0.8297	2.821	101.10	0.7029	1.423				67.946	0.0393	0.2941	25.44				
	x	12(0.109)	2.657	0.9472	3.220	100.16	0.6956	1.438				66.536	0.0385	0.2880	25.97				
	x	11(0.120)	2.635	1.0386	3.531	99.34	0.6898	1.450				65.439	0.0379	0.2833	26.38				
	z	10(0.134)	2.607	1.1539	3.923	98.28	0.6825	1.465				64.055	0.0371	0.2772	26.95				
	z	9(0.148)	2.579	1.2679	4.310	97.23	0.6752	1.481				62.687	0.0363	0.2713	27.54				
3	x	16(0.065)	2.870	0.5994	2.038	108.20	0.7514	1.331	113.10	0.7854	1.273	77.621	0.0449	0.3360	22.27	7.069	84.823	0.0491	0.3373
	x	14(0.083)	2.834	0.7606	2.586	106.84	0.7419	1.348				75.696	0.0438	0.3276	22.83				
	x	13(0.095)	2.810	0.8671	2.947	105.93	0.7357	1.359				74.419	0.0431	0.3221	23.20				
	x	12(0.109)	2.782	0.9900	3.366	104.88	0.7283	1.373				72.943	0.0422	0.3157	23.70				
	x	11(0.120)	2.760	1.0857	3.691	104.05	0.7226	1.384				71.794	0.0415	0.3107	24.10				
	z	10(0.134)	2.732	1.2065	4.102	102.99	0.7152	1.398				70.345	0.0407	0.3045	24.57				
	z	9(0.148)	2.704	1.3262	4.508	101.94	0.7079	1.413				68.911	0.0400	0.2983	25.00				

See sheet 1 for explanation of x, y and z.

From *Manual of Welded Steel Tubing for Heat Exchanger and Condenser Use*, by permission of Formed Steel Tube Institute.

Here's BROWN FINTUBE'S latest development...

Using BROWN'S resistance-welded, integrally-bonded construction...They increase the heat transferring capacity of certain heat exchangers by a full 50%

● Brown Fintubes with their exclusive, resistance-welded integrally-bonded construction assure high thermal efficiency and trouble-free operation —And, of even greater importance, enables one lineal foot of Brown Fintube to provide the heat transfer capacity of from 4 to 10 lineal feet of plain bare tubing. Consequently, a fewer number, or shorter, Brown Fintubes are needed for a given heat transfer service than if plain bare tubes were used, resulting in *very substantial* saving in heat exchanger shell sizes—weights—pressure drops . . . and manufacturing, shipping, installation and maintenance costs.

Now, Brown Engineers have developed "cut and twisted" fintubes—secured by taking standard "longitudinal" fintubes,— cutting the fins transversely at desired intervals, and twisting the ends. These "cut and twisted" fintubes produce greater turbulency in the shell side commodity than straight untwisted fintubes, resulting in increased thermal efficiencies ranging up to 50% in Sectional Hairpin Exchangers, with *still further* savings in shell size, weight, shipping and manufacturing costs, etc.

Brown "longitudinal" and "cut and twisted" Fintubes are available in 6 standard—and many special types—of Brown Fintube Heat Exchangers —one or another of which will meet practically every requirement for effecting heat transfers between liquids and gases, or other commodities having unequal transfer co-efficients . . . Also in exchangers built by a considerable number of other concerns who regularly employ Brown Fintubes as the heat transfer medium in their exchangers. Let us quote on your requirements.

Brown Integrally Bonded Fintubes are used in all Brown Fintube Heat Exchangers—in exchangers made by most other manufacturers—and are available in a wide variety of sizes, and in mild carbon or special steels, for practically any heating or cooling requirement.

THE BROWN FINTUBE CO.

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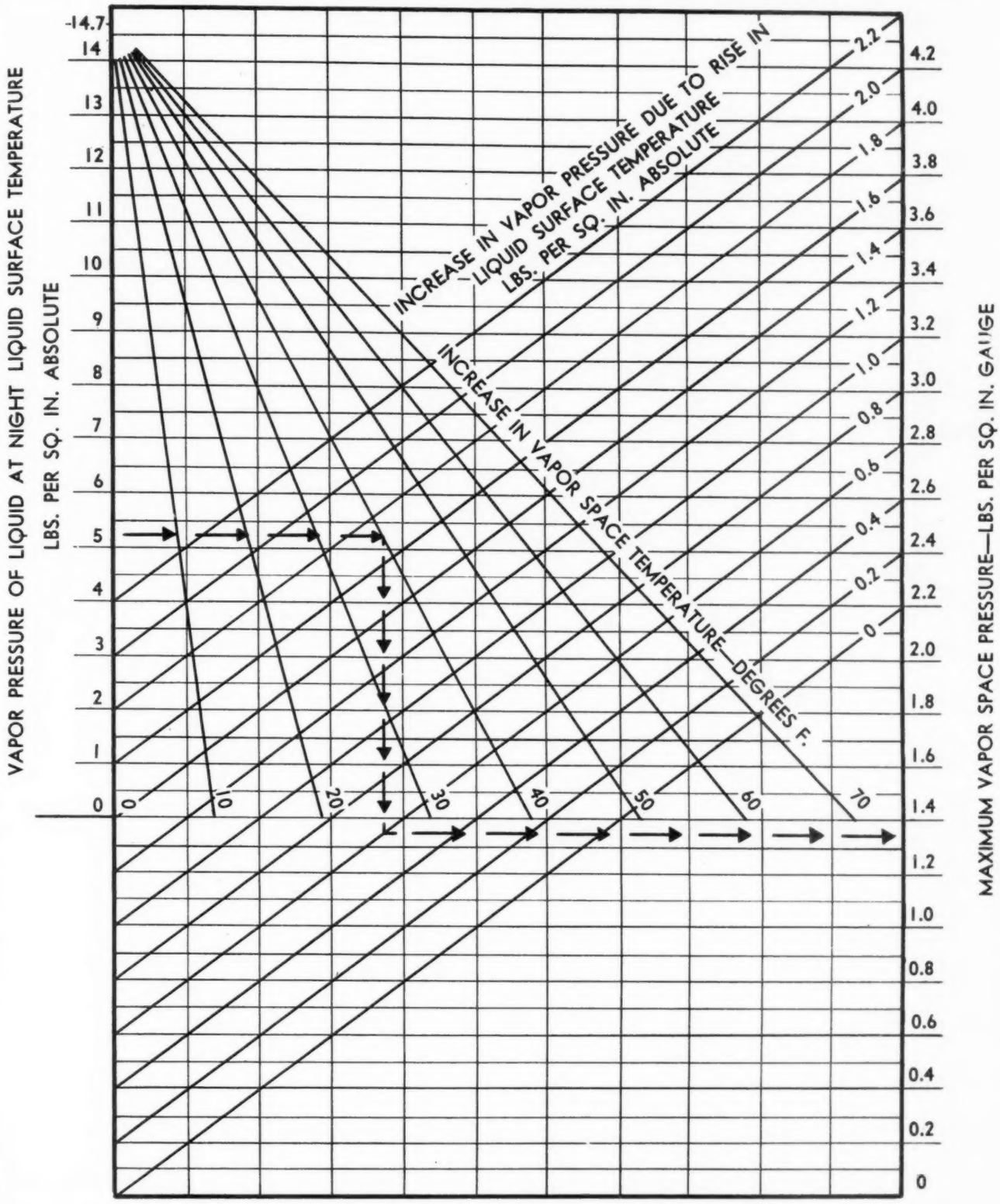
MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS

PRESSURES OF AIR-VAPOR MIXTURES IN PRESSURE CONTAINERS



Arrows on the chart do not correspond to example, but show directions through chart.

—*Chart by Chicago Bridge and Iron Company, 1942.*

NOTE: This chart is for finding the storage pressure required to prevent breathing loss from products of relatively low volatility. *Example:* Find the storage pressure required to prevent breathing loss from a 10-lb. R.V.P. motor gasoline under the following conditions: Daily vapor space temperature variation, 50°F.; day liquid surface temperature, 80°F.; and night liquid surface temperature, 70°F. From table P 640.1 vapor pressure at 80°F. is 7.6 lb. per sq. in. and at 70°F. is 6.3 lb. per sq. in. abs. The difference or increase in vapor pressure is 1.3 lb. per sq. in. abs. Enter the above chart on the left at 6.3 lb., move across to 50°F. temperature variation, then down to vapor pressure increase of 1.3 lb., then across to the required storage pressure of 2.12 lb. per sq. in. ga.

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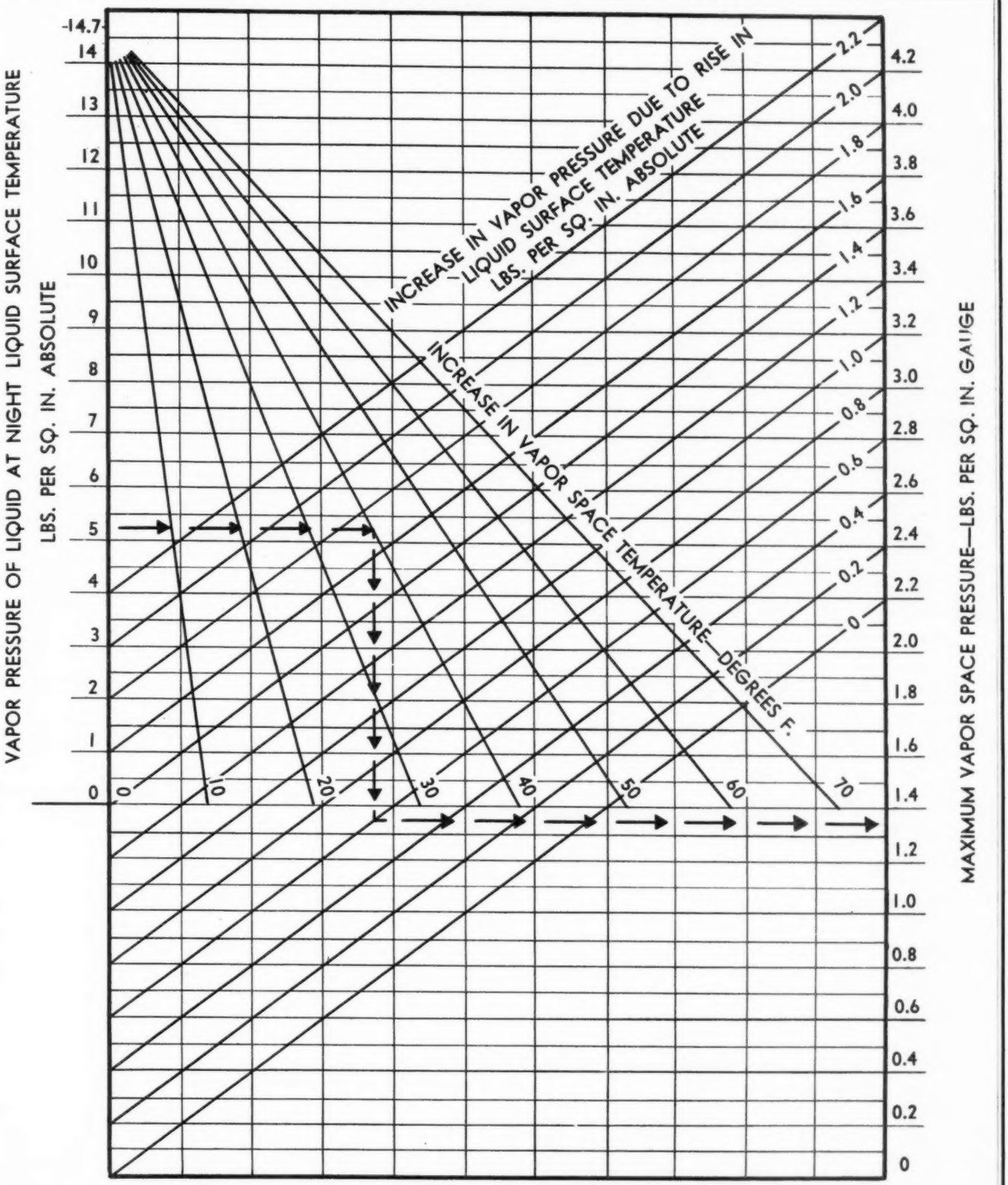

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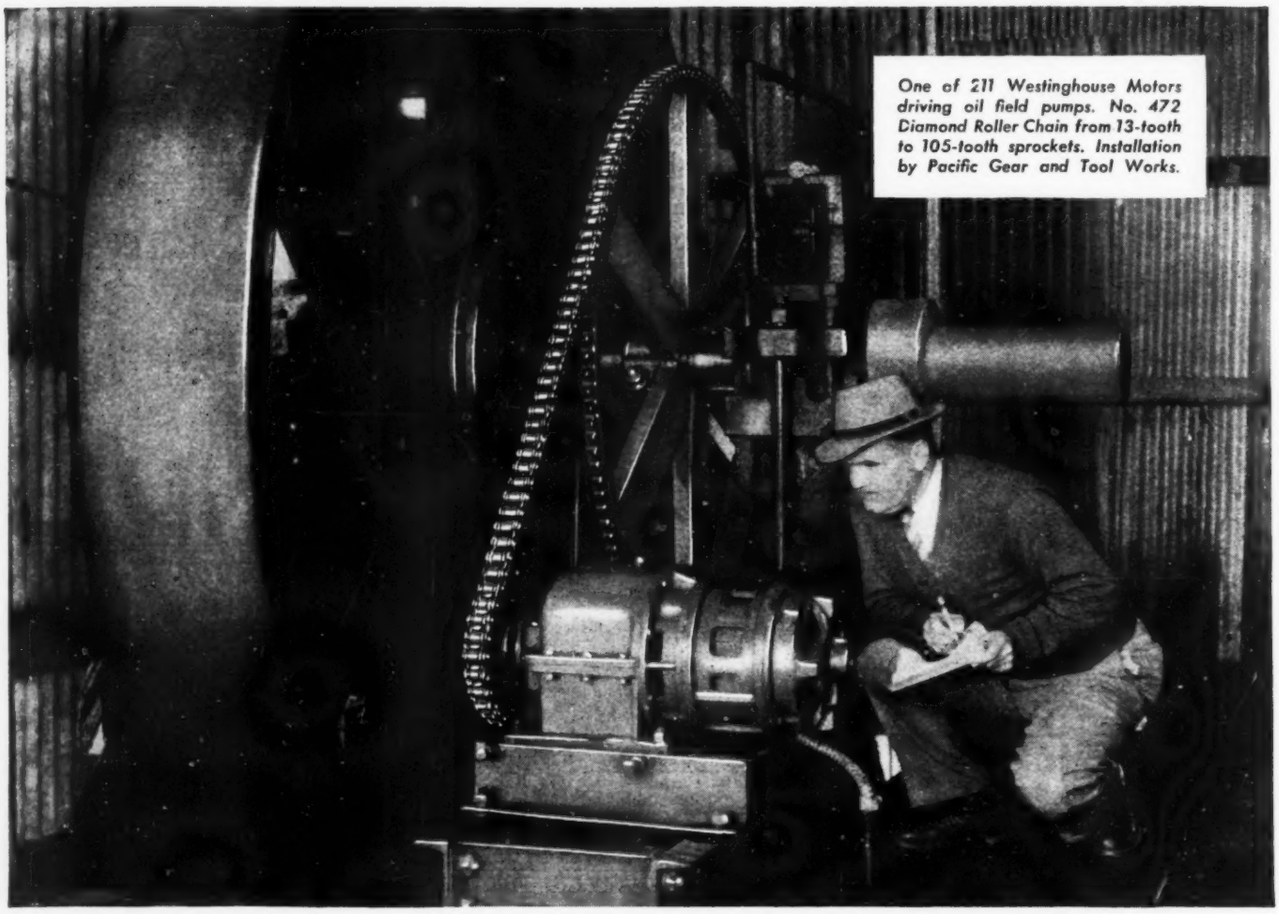

One of 211 Westinghouse Motors driving oil field pumps. No. 472 Diamond Roller Chain from 13-tooth to 105-tooth sprockets. Installation by Pacific Gear and Tool Works.

211 ROLLER CHAIN MOTOR DRIVES REPLACE GAS ENGINE DRIVES

To Release Fuel Gas for Industrial and War Purposes

To release fuel gas so badly needed for industrial and war purposes in southern California, a large oil producing company has replaced 211 gas engines with electric motors for continuous pumping operation, all equipped with roller chain drives.

Diamond Roller Chains are particularly suited for these high-ratio short-center drives because they permit no slipping, insure the exact speed ratio desired and require little or no maintenance or replacement service. Gripping at a multiple number of teeth there is no difficulty because of the great variance between the small wheel or driver and the large wheel. Great strength for weight and size,—reliability and long life contribute added advantages offered only by such drives.

The changeover to motor drives not only releases gas formerly consumed for this pumping service but is said to effect considerable economy of operation with less supervision and servicing.

Diamond Drives can perform equally well for you—and meet most all power transfer requirements in capacities from a fraction of a horsepower to 1500, and for very low speeds up to 4500 r.p.m. Engineering recommendations are yours for the asking . . . DIAMOND CHAIN & MFG. CO., 441 Kentucky Avenue, Indianapolis, Indiana. Tulsa Office: 2238 Terwilleger Blvd.

DIAMOND **ROLLER CHAINS**

Static Press.
2200-2295 lb.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Differential press ire, in. of water	Static pressure, lb. per sq. in., ga.																			
	2200	2205	2210	2215	2220	2225	2230	2235	2240	2245	2250	2255	2260	2265	2270	2275	2280	2285	2290	2295
2	66.54	66.63	66.70	66.77	66.85	66.92	66.99	67.07	67.15	67.22	67.29	67.36	67.45	67.52	67.59	67.66	67.74	67.82	67.89	67.96
4	94.12	94.24	94.34	94.44	94.56	94.66	94.76	94.86	94.98	95.08	95.18	95.28	95.40	95.50	95.60	95.70	95.82	95.92	96.02	96.12
6	115.2	115.4	115.5	115.6	115.8	115.9	116.0	116.2	116.3	116.4	116.5	116.7	116.8	116.9	117.1	117.2	117.3	117.5	117.6	117.7
8	133.1	133.3	133.4	133.5	133.7	133.8	133.9	134.1	134.3	134.4	134.6	134.7	134.9	135.0	135.2	135.3	135.5	135.6	135.8	135.9
10	148.8	148.9	149.2	149.3	149.5	149.7	149.8	149.9	150.2	150.3	150.5	150.6	150.8	150.9	151.1	151.3	151.5	151.6	151.8	151.9
12	163.0	163.2	163.4	163.6	163.8	163.9	164.1	164.3	164.5	164.7	164.8	165.0	165.2	165.4	165.6	165.8	165.9	166.1	166.3	166.5
14	176.1	176.3	176.5	176.7	176.9	177.1	177.3	177.5	177.7	177.9	178.1	178.3	178.5	178.7	178.9	179.1	179.3	179.5	179.6	179.8
16	188.2	188.5	188.7	188.9	189.1	189.3	189.5	189.7	189.9	190.2	190.4	190.6	190.8	191.0	191.2	191.4	191.6	191.8	192.0	192.2
18	199.7	199.9	200.1	200.4	200.6	200.8	201.0	201.2	201.5	201.7	201.9	202.1	202.4	202.6	202.8	203.0	203.3	203.5	203.7	203.9
20	210.5	210.7	210.9	211.2	211.4	211.7	211.9	212.1	212.4	212.6	212.8	213.0	213.3	213.5	213.8	213.9	214.3	214.5	214.7	214.9
21	215.6	215.9	216.1	216.4	216.6	216.9	217.1	217.3	217.6	217.8	218.1	218.3	218.6	218.8	219.0	219.2	219.5	219.8	219.9	220.2
22	220.7	220.9	221.2	221.5	221.7	221.9	222.2	222.4	222.7	222.9	223.2	223.4	223.7	223.9	224.2	224.4	224.7	224.9	225.2	225.4
23	225.7	225.9	226.2	226.5	226.8	226.9	227.2	227.5	227.8	228.0	228.2	228.5	228.8	229.0	229.2	229.5	229.8	230.0	230.3	230.5
24	230.5	230.8	231.1	231.3	231.7	231.9	232.1	232.4	232.7	232.9	233.1	233.4	233.7	233.9	234.2	234.4	234.7	234.9	235.2	235.4
25	235.2	235.6	235.9	236.1	236.4	236.7	236.9	237.2	237.5	237.7	237.9	238.2	238.5	238.8	239.0	239.3	239.6	239.8	240.1	240.3
26	239.9	240.3	240.5	240.8	241.1	241.3	241.6	241.8	242.2	242.2	242.7	242.9	243.2	243.5	243.7	243.9	244.3	244.5	244.8	245.1
27	244.5	244.8	245.1	245.4	245.7	245.9	246.2	246.4	246.7	247.0	247.3	247.5	247.8	248.1	248.4	248.6	248.9	249.2	249.5	249.7
28	249.0	249.4	249.6	249.9	250.2	250.5	250.7	250.9	251.3	251.6	251.8	252.1	252.4	252.7	252.9	252.3	253.5	253.8	254.1	254.3
29	253.4	253.7	254.0	254.3	254.6	254.9	255.1	255.4	255.7	256.0	256.3	256.5	256.9	257.1	257.4	257.7	257.9	258.3	258.5	258.8
30	257.7	258.1	258.4	258.6	258.9	259.2	259.5	259.8	260.1	260.4	260.7	260.9	261.3	261.5	261.8	262.1	262.4	262.7	262.9	263.2
31	262.0	262.4	262.6	262.9	263.3	263.5	263.8	264.1	264.4	264.7	264.9	265.3	265.6	265.9	266.2	266.4	266.8	267.0	267.3	267.6
32	266.2	266.6	266.8	267.1	267.5	267.7	268.0	268.3	268.7	268.9	269.2	269.5	269.8	270.1	270.4	270.7	271.0	271.6	271.6	271.9
33	270.4	270.7	270.9	271.3	271.6	271.9	272.2	272.5	272.8	273.1	273.4	273.7	274.0	274.3	274.6	274.9	275.2	275.5	275.8	276.1
34	274.4	274.8	275.0	275.3	275.7	275.9	276.3	276.6	276.9	277.2	277.5	277.8	278.1	278.4	278.7	279.0	279.1	279.7	279.9	280.2
35	278.4	278.8	279.1	279.4	279.7	280.0	280.3	280.6	280.9	281.2	281.5	281.8	282.2	282.5	282.8	283.1	283.4	283.7	284.0	284.3
36	282.4	282.7	283.0	283.3	283.7	283.9	284.3	284.6	284.9	285.2	285.5	285.8	286.2	286.5	286.8	287.1	287.5	287.8	288.1	288.4
37	286.3	286.6	286.9	287.2	287.6	287.9	288.2	288.5	288.9	289.2	289.5	289.8	290.2	290.5	290.8	291.1	291.4	291.7	292.0	292.3
38	290.1	290.4	290.8	291.1	291.4	291.7	292.1	292.4	292.7	293.0	293.3	293.7	294.0	294.3	294.6	294.9	295.3	295.6	295.9	296.2
39	293.9	294.3	294.6	294.9	295.3	295.6	295.9	296.2	296.6	296.9	297.2	297.5	297.9	298.2	298.5	298.8	299.2	299.5	299.8	300.1
40	297.7	298.0	298.4	298.7	299.0	299.4	299.7	299.9	300.4	300.7	301.0	301.3	301.7	302.0	302.3	302.7	303.0	303.3	303.7	303.9
41	301.3	301.7	302.0	302.3	302.7	303.1	303.4	303.7	304.1	304.4	304.7	305.0	305.4	305.7	306.1	306.4	306.8	307.1	307.4	307.7
42	304.9	305.4	305.7	306.3	306.4	306.7	307.1	307.4	307.8	308.1	308.4	308.8	309.1	309.5	309.8	310.1	310.5	310.8	311.2	311.5
43	308.6	308.9	309.3	309.6	310.0	310.3	310.7	310.9	311.4	311.7	312.0	312.4	312.8	313.1	313.4	313.8	314.1	314.5	314.8	315.1
44	312.1	312.5	312.9	313.2	313.6	313.9	314.3	314.6	315.0	315.3	315.7	315.9	316.4	316.7	317.1	317.4	317.8	318.1	318.5	318.8
45	315.7	316.1	316.4	316.8	317.2	317.5	317.8	318.2	318.6	318.9	319.2	319.6	319.9	320.3	320.6	320.9	321.4	321.7	322.1	322.4
46	319.2	319.6	319.9	320.2	320.7	320.9	321.3	321.7	322.1	322.4	332.8	323.1	323.5	323.8	324.2	324.5	324.9	325.3	325.6	325.9
47	322.6	323.1	323.4	323.7	324.2	324.5	324.8	325.2	325.6	325.9	326.3	326.6	327.0	327.4	327.7	328.1	328.5	328.8	329.2	329.5
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49	329.4	329.8	330.2	330.5	330.9	331.3	331.7	332.0	332.4	332.8	333.1	333.5	333.9	334.3	334.6	334.9	335.4	335.7	336.1	336.4
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58	358.4	358.9	359.2	359.6	360.1	360.5	360.8	361.2	361.7	362.1	362.4	362.8	363.3	363.7	364.0	364.4	364.9	365.3	365.6	366.0
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60	364.5	364.9	365.4	365.8	366.2	366.6	367.0	367.4	367.8	368.2	368.6	369.0	359.5	369.9	370.3	370.6	371.1	371.5	371.9	372.3
61	367.5	368.0	368.4	368.8	369.3	369.7	370.0	370.4	370.9	371.3	371.7	372.1	372.5	372.9	373.3	373.7	374.2	374.6	374.9	375.3
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63	373.5	373.9	374.4	374.8	375.3	375.7	376.1	376.5	376.9	377.3	377.7	378.1	378.6	378.9	379.4	379.8	380.3	380.7	381.1	381.5
64	376.5	376.9	377.4	377.8	378.2	378.6	379.0	379.4	379.9	380.3	380.7	381.1	381.6	382.0	382.4	382.8	383.3	383.7	384.1	384.5
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79	418.3	418.8	419.2	419.7	420.2	420.7	421.1	421.6	422.1	422.5	422.9	423.4	423.9	424.4	424.8	425.3	425.8	426.3	426.7	427.2
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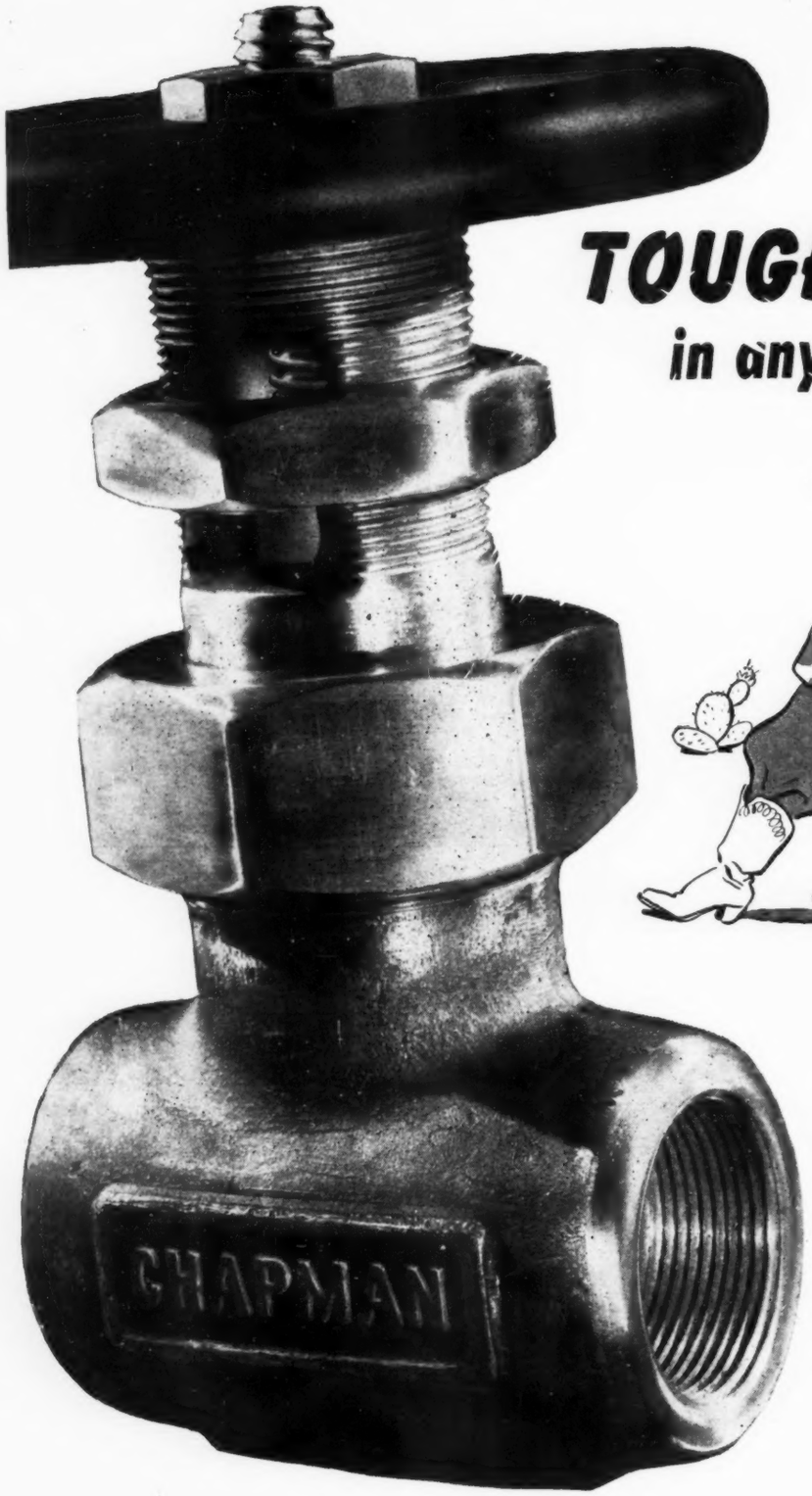
86	436.4	436.9	434.5	437.9	438.5	438.9	439.4	439.9	440.4	440.9	441.3	441.8	442.4	442.8	443.3	443.8	444.3	444.8	445.2	445.7
88	441.5	442.0	442.5	442.9	443.5	444.0	444.5	444.9	445.5	445.9	446.4	446.9	447.5	447.9	448.4	448.9	449.4	449.9	450.4	450.9
90	446.5	447.0	447.5	447.9	448.5	449.0	449.5	449.9	450.5	451.0	451.5	451.9	452.5	453.0	453.5	453.9	454.5	454.9	455.5	455.9
92	451.4	451.9	452.5	452.9	453.5	453.9	454.5	454.9	455.5	456.0	456.5	456.9	457.5	458.0	458.5	458.9	459.6	460.0	460.5	460.9
94	456.2	456.8	457.3	457.8	458.4	458.9	459.4	459.8	460.4	460.9	461.4	461.9	462.5	462.9	463.4	463.9	464.5	464.9	465.5	465.9
96	461.1	461.7	462.2	462.7	463.2	463.7	464.2	464.7	465.3	465.8	466.3	466.8	467.4	467.9	468.3	468.8	469.4	469.9	470.4	470.9
98	465.8	466.4	466.9	467.4	468.0	468.5	469.0	469.5	470.0	470.6	471.1	471.6	472.2	472.7	473.2	473.7	474.3	474.8	475.3	475.7
100	470.6	471.2	471.7	472.2	472.8	473.3	473.8	474.3	474.9	475.4	475.9	476.4	477.0	477.5	478.0	478.5	479.1	479.6	480.1	480.6

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.



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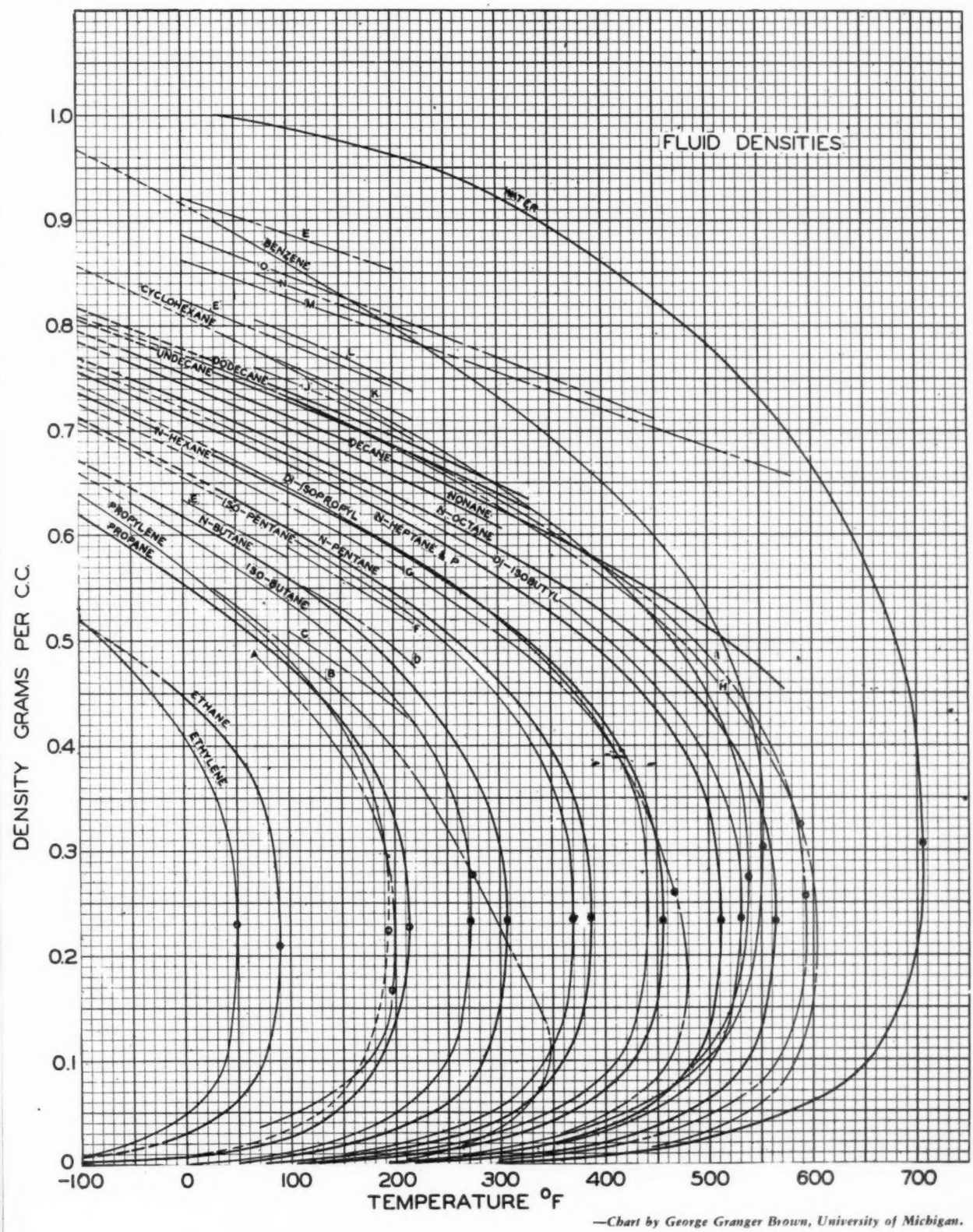
HYDROCARBON FLUID DENSITIES

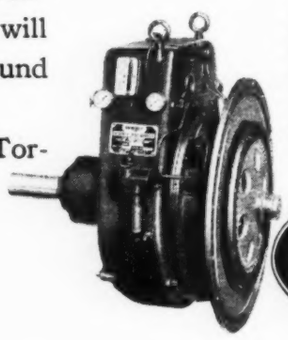


—Chart by George Granger Brown, University of Michigan.

Right now, we must use, to its highest efficiency, the equipment we have . . . keep it working at its best by careful attention to every service need . . . lubrication, adjustment of clutches, replacement of worn out parts where necessary. But while you're putting in your "best licks" now, think of the better rigs you'll be able to buy when the war is over.

First: internal combustion engines will be more efficient; will give you more power per pound of engine.

Second: with Twin Disc Torque Converters (Lysholm-Smith type) built in as original equipment, you will be able to drill more feet, in less time, at a lower cost. There will be less wear and tear on your equipment because the Torque Converter, in addition to giving you the necessary torque multiplication to lift heavier loads easier, will cushion out the cyclic variations of the engine . . . prevent the transmission of shock loads to wire ropes or cables. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin.



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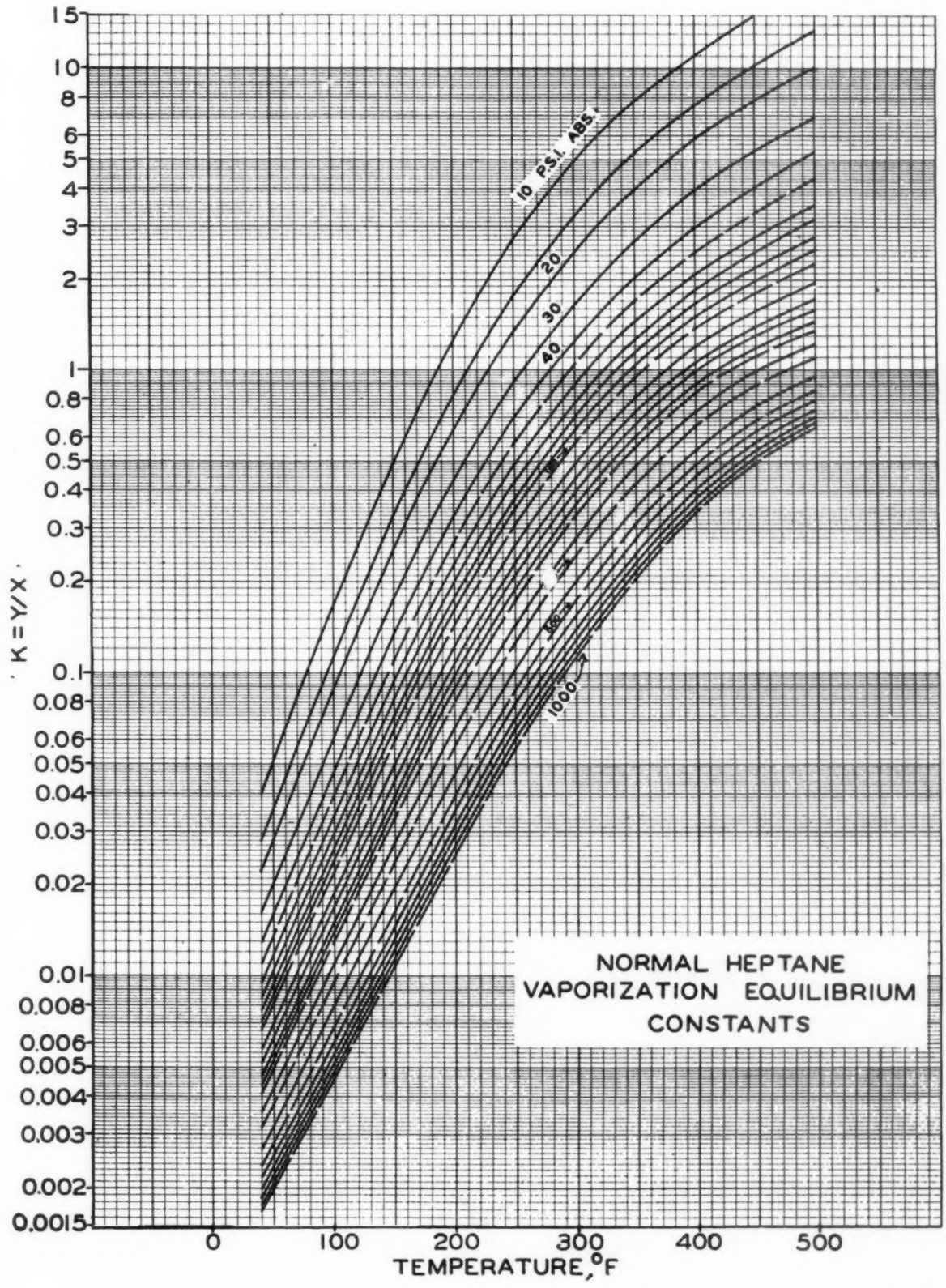
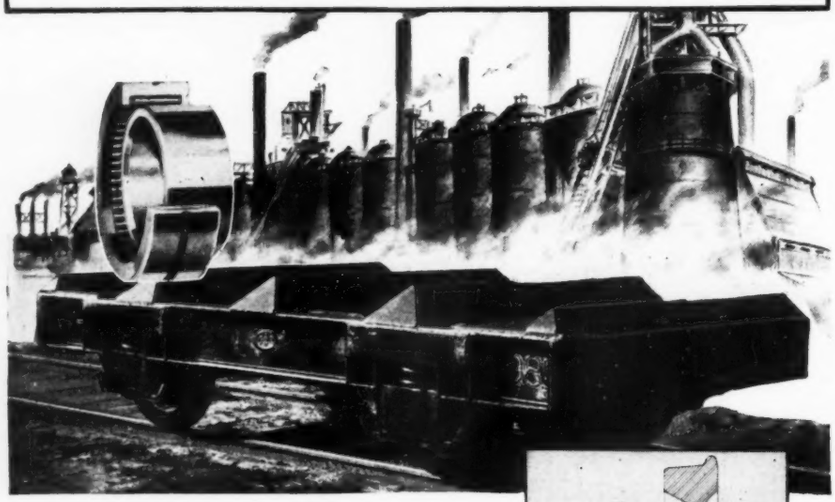
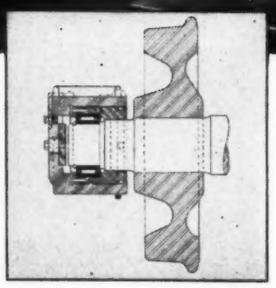


Chart by George Granger Brown, University of Michigan.

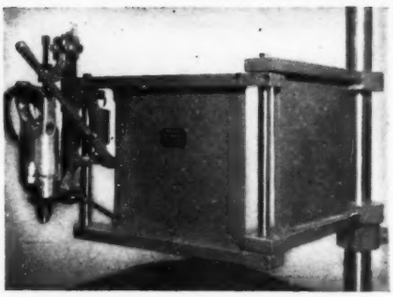
IN THE NEWS
WITH TORRINGTON—BANTAM



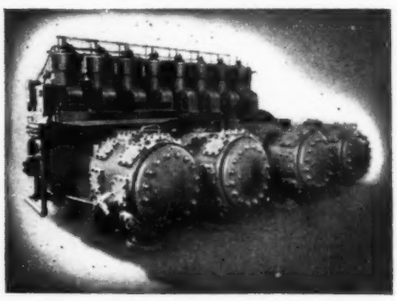
25 TONS OF CHARGE are carried by buggies like this one, to feed the steel furnaces at the Kaiser plant on the West Coast. Constructed by the American Car and Foundry Company, these cars employ Needle Bearings Type NCS on the axles, as shown in drawing. Efficient service is contributed by the low friction coefficient, high load capacity and effective lubrication method of these bearings.



FARM PLANTING is made easier by this heavy-duty "Rototiller" which prepares seed beds all ready for planting in a single operation. Needle Rollers Type LN are assembled into economical, high-capacity anti-friction bearings on both ends of the connecting rods and on the wheels of this progressively designed unit. The rollers at the wrist pin end are projected beyond the connecting rod in such a way that they are constantly lubricated by a fog of oil from the crankcase. At the lower end, oil catches are used.



DRILL PRESS OPERATION was obtained in this Black & Decker portable drill through the development of a radial arm attachment to speed production in an airplane factory. Compact arm design and flexibility over a wide radius of operation are combined with anti-friction performance through the use of NCS Needle Bearings—a typical case where the small size and high load capacity of these bearings have proven important advantages.



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SOUTH BEND, INDIANA

Treatment of Liquid-Phase Cracked Gasolines With Zinc Chloride[1]

☆ High-grade gasoline with improved octane number can be obtained, experiments show

by M. M. Gerasimov, V. E. Glushnev, S. F. Vasil'ev, and S. N. Solodov

Mendeleev Experimental Oil Refinery, Moscow

THE investigation pertaining to the treatment of liquid-phase cracked gasolines with zinc chloride[2] that was carried out in the vapor-phase cracking laboratory "IGI" of the Academy of Science of the U. S. S. R. gave fairly satisfactory results. A pressure distillate from the Winkler-Koch cracking unit in the "Mendeleev" refinery was used in the laboratory experiments. The zinc chloride treatment consisted of the following cycle of operations: the raw material (pressure distillate from the Winkler-Koch cracking unit) was washed with a weak solution of sodium bicarbonate[3] and then pumped through a Foster-Wheeler type pipe still (where it was heated to a temperature of 225° C.) into the lower part of the refining tower charged with a catalyst precipitated on particles of coke. The coke particles ranged between 2 and 12 mm. in size. The temperature of the refining tower was maintained at 220 to 225° C. After passing through a layer of the coke packing coated with the precipitated catalyst, the vapors of the pressure distillate from the top of the refining tower entered the bottom of the bubble tower. The conditions maintained within the bubble tower depended upon whether the final product was to be high gravity gasoline or motor fuel. Vapors from the top of the bubble tower passed through condensers and coolers before entering the gas separator from whence the condensed products passed to run-down tanks and finally into storage tanks. When it was intended to make high-gravity gasoline the temperature in the upper part of the bubble tower was maintained at 98 to 100°C., and when manufacturing motor fuel the temperature was 165 to 170°C.

Catalyst

In the refinery-scale experiments pertaining to the refining of Winkler-Koch pressure distillate with zinc chloride, coke from the Don Basin measuring 2 to 12 mm. in size was used for tower packing. Zinc chloride was deposited on the coke by immersing the coke in specially constructed bunkers in a solution of $ZnCl_2$ of 45° Bé. for 3 hours. The coke then was dried and transferred into the refining tower. The coke packing thus prepared and used in the experiments had about 10 percent $ZnCl_2$ (by weight) deposited on its surfaces.

The raw material, which had been washed preliminarily with soda, had the following physical-chemical characteristics:

Density at 20°C.	0.764
Acidity, mg.	0.6
Gums, mg.	3.2
Corrosion test	satisfactory
Induction period	230 min. (without inhibitors)
Octane number	88.4

Characteristics of Products

Characteristics of products obtained in the refinery-scale refining are as follows:

(a) Light gasoline. The refined gasoline from the gas separator entered a run-down tank having a capacity of 14 cu. m., and after the unit was full an average sample of the gasoline was obtained. The following tests then were made on the gasoline: acidity, induction period, doctor, corrosion, and an Engler distillation. Such a succession of control determinations permitted establishing the degree of refining possible with the catalyst as dependent upon the amount of pressure distillate that passed through the tower packing for a definite consumption of zinc chloride; they established also the characteristics of the commercial products that could be made from gasolines having the properties of the average sample.

The Engler distillation of the gasoline showed the following:

Initial boiling point 40°C.
60°C. 5.5 percent

TABLE 1

Number of the sample and that of run-down tanks	Acid after washing the refined gasoline with water	Induction period of refined light gasoline, min.	
		Without inhibitor	With 5 mg. α-naphthol
1	0.24	155	.....
2	0.36	120	More than 710 min.
3	0.12	120	.....
4	0.10	90	.....
5	0.12	75	.....
6	0.18	80	.....
7	0.30	70	More than 800 min.
8	0.38	60	.....
9	0.48	60	.....
10	0.48	40	.....
11	0.54	40	.....
12	0.24	40	More than 450 min.
13	0.36	40	.....
14	0.36	40	.....

TABLE 2

Sample number	Sample	Actual gums (initial) in mg.	Acidity after washing refined gasoline with water	Induction period, min.	
				Without inhibitor	With 5 mg. α-naphthol
1	Mixture of the first five run-down tanks....	0.0	0.36	150	...
2	Mixture of gasoline from nine run-down tanks.....	0.0	0.24	100	960
3	Mixture of gasoline from 13 run-down tanks.	0.0	0.36	50	700
4	Light commercial gasoline from storage tank No. 69 during the entire operation of the refining unit.....	0.8*	0.36†	50	520

*The amount of gum shown refers to a gasoline that was stabilized with α-naphthol on the basis of 5 mg. per 100 cc. of the product.
†The acidity after oxidation in the bomb was 78 mg. per 100 cc. of gasoline.

[1]Translated from the Russian oil publication *Neftyanoe Khozyaistvo*, 1940, No. 2 by A. A. Boehtlingk, Berkeley, California.

[2]Cf. *Neftyanoe Khozyaistvo*, 1939, No. 6, 43-47. For English translation see *Foreign Petroleum Technology*, 8, 351, 1940.

[3]The basic commercial properties of refined gasolines (gum content, induction period, acidity, and octane rating) are independent of the caustic treatment. Therefore, a preliminary treatment of the pressure distillate from the Winkler-Koch unit with caustic or soda before treatment with zinc chloride is unnecessary.

70°C. 11.5 percent
80°C. 15.5 percent
90°C. 21.0 percent
100°C. 25.5 percent
110°C. 31.5 percent
120°C. 37.5 percent
130°C. 42.0 percent
140°C. 49.0 percent
150°C. 54.5 percent
160°C. 60.0 percent
170°C. 67.0 percent
180°C. 71.0 percent
190°C. 75.5 percent
200°C. 86.5 percent
210°C. 87.5 percent
220°C. 91.5 percent
Endpoint 228°C.
Residue 1.5 percent
Losses 5.0 percent
Yield 93.5 percent

The physical-chemical properties of the samples of refined gasoline taken for control analyses from a number of refinery run-down tanks of the zinc chloride unit are given in Table 1.

Table 2 summarizes the characteristics of the average mixtures of refined light gasolines from a number of run-down tanks.

It may be noted from Tables 1 and 2 that the length of the induction period of the gasoline without inhibitor decreased with increase in the amount of pressure distillate passed through the catalyst; upon further refining, however, the time remains constant at 40 min. The quantity of actual gum in all samples is zero. The acidity of the gasoline remained approximately constant and changed but little with the time of operation of the treating tower. The induction period of gasoline of the same fractional composition, although produced in the twin-furnace cracking unit of Soviet construction and treated with fresh clay[4] (at a 21 percent consumption of the clay) amounted to 10 min. with an unsatisfactory doctor test, which was negative in the experiments reported here. The octane numbers of gasolines obtained from the pressure distillates of the Winkler-Koch units and treated with zinc chloride were 75.5 to 76.5, whereas the gasoline treated with clays had an octane number of not more than 72 for the same fractional composition. Thus, the gasolines treated with zinc chloride were superior to vapor-phase gasolines treated with clay. The zinc chloride unquestionably is a more effective catalyst than clay. The fractional composition of the refined gasolines as determined by control analyses of the gasolines in the run-down tanks remained constant.

Table 3 gives the fractional compositions of the refined light gasolines composed of mixtures of gasoline from a number of run-down tanks.

[4]The writers are now investigating the effect of such clays as bentonites and bauxites as carriers of zinc chloride and other catalysts.

The light gasoline obtained from the Winkler-Koch pressure distillate in the refining of the distillate with zinc chloride[5] is a high-grade gasoline judging by its fractional composition, octane number, gum content, and other physical-chemical properties.

(b) Motor fuel. A pressure distillate from the Winkler-Koch cracking unit was treated with $ZnCl_2$ (without interrupting the process) in the same tower following the treatment of the light gasoline, for the preparation of motor fuel. The analyses of the average samples of the refined motor fuel compounded from gasoline drawn from different run-down tanks are given in Table 5.

Data given in Tables 4 and 5 show that the induction period for the motor

[5]Based on the volume of pressure distillate, the consumption of $ZnCl_2$ in the preparation of the light gasoline amounted to 0.29 percent; the consumption of the catalyst was 0.19 percent when treating motor fuel. The tower packing was not consumed during the refining process and could be used again.

TABLE 3

	Yield in percent			
	Mixture of gasoline from 5 run-down tanks	Mixture of gasoline from 9 run-down tanks	Mixture of gasoline from 13 run-down tanks	Commercial gasoline
Density at 20° C	0.711	0.706	0.704	0.707
I.B.P. °C	35	38	34	35
Boiling up to 40° C.	2.5	1.0	1.5	2.0
50° C.	7.5	9.0	8.0	5.0
60° C.	16.5	19.0	16.5	16.5
70° C.	27.0	30.0	26.0	24.5
80° C.	36.0	40.0	36.0	35.0
90° C.	46.0	49.5	47.0	45.5
100° C.	56.0	59.0	58.0	56.5
110° C.	67.0	70.0	69.0	68.0
120° C.	78.0	79.5	79.5	77.5
130° C.	88.0	87.5	87.0	86.0
140° C.	92.0	90.0	92.0	90.0
150° C.				
Endpoint	150° C.	144° C.	145° C.	149° C.
Yield, percent	94.5	91.5	94.0	92.0
Residue, percent	1.0	1.0	1.0	1.0
Losses, percent	4.5	7.5	5.0	7.0

TABLE 4

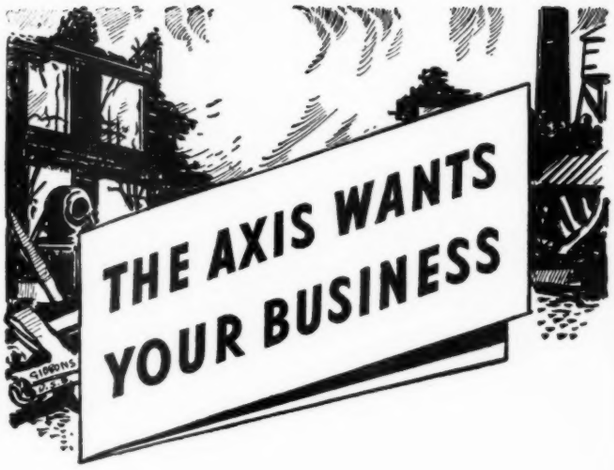
Sample No.	Run-down tank No.	Actual gums (initial) in mg.	Acidity after washing treated gasoline with water	Corrosion properties	Induction period, min.	
					Without inhibitor	With 5 mg. α-naphthol
1	2	3.2	0.96	Satisfactory	310	
2	3	3.2	0.66	Satisfactory	220	
3	4	2.4	0.72	Satisfactory	280	
4	5	3.2	0.66	Satisfactory	240	
5	6	2.4	0.6	Satisfactory	260	
6	7	2.4	0.6	Satisfactory	260	Above 800
7	8	2.4	0.78	Satisfactory	250	
8	9	2.4	0.78	Satisfactory	260	
9	10	2.4	0.72	Satisfactory		
10	11	2.4	0.84	Satisfactory	240	
11	12	2.4	0.78	Satisfactory	270	
12	13	2.4	0.79	Satisfactory		
13	14	2.4	0.72	Satisfactory	230	Above 700

TABLE 5

Sample	Induction period, min.		Gum, mg.	Acidity	Corrosion properties
	Without inhibitor	With 5 mg. α-naphthol			
Mixture from 4 run-down tanks	290		2.4	0.84	Satisfactory
Mixture from 8 run-down tanks	310		2.4	1.26	Satisfactory
Motor fuel during the entire operation of the treating unit	250	620	3.2	0.76	Satisfactory

TABLE 6

Fraction at °C.	Mixture of gasoline from 4 run-down tanks	Mixture of gasoline from 6 run-down tanks	Commercial gasoline
Density at 20° C	0.761	0.775	0.763
I.B.P. °C	33.0	36.5	31
Boiling up to 40° C	3.0		2.0
50° C	7.0	5.0	5.0
60° C	10.0	11.5	9.5
70° C	14.0	18.0	14.0
80° C	21.0	21.5	21.0
90° C	27.0	30.0	28.0
100° C	33.0	35.5	32.0
160° C	68.0	70.0	71.0
200° C	87.0	82.0	86.5
220° C			
Endpoint, °C	221	217	216
Yield, percent	95.0	93.5	98.0
Residue, percent	2.0		1.0
Losses, percent	3.0	3.5	1.0



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fuel treated with zinc chloride remains within the requirements for commercial gasoline during the entire cycle of operations. Regarding the other physical-chemical properties, they too are within the standards accepted for gasolines treated with sulphuric acid as well as for those treated with caustic followed by stabilization with α-naphthol. The octane number of the motor fuel treated with $ZnCl_2$ is higher than that of motor fuel treated with H_2SO_4 and clays, and amounts to 73.5. The properties of the motor fuel treated with zinc chloride correspond to the standards of American motor fuels.

Table 6 gives the fractional composition of average samples of motor fuel for mixtures taken from a number of run-down tanks, as well as that of the standard-grade gasoline collected during the entire treating period.

The fractional composition of the gasoline is quite satisfactory. The content of light fractions in the motor fuel boiling below 100°C. fluctuated between 32 and 35.5 percent and fractions boiling below 160°C. exceeded 65 percent. According to the fractional composition, this gasoline excells existing standards for cracked automobile gasoline. The presence of such a potential of light fractions in the motor fuel permits increasing the yield of gasoline by several percent (by raising the endpoint) without lowering its basic properties or octane number, or affecting its stability not to deteriorate while in storage.

When preparing light cracked gasoline in the zinc-chloride treating unit, a condensate of the following fractional composition was obtained from the lower end of the bubble tower.

Density at 20°C. = 0.836
I.B.P. = 150°C.

Boiling below	160°C.	10 percent
	170°C.	20.5 percent
	180°C.	40.0 percent
	190°C.	53.0 percent
	200°C.	68.0 percent
	210°C.	83.0 percent
	220°C.	91.5 percent
	230°C.	95.0 percent
	240°C.	96.0 percent
	250°C.	97.0 percent

Endpoint = 227°C.
Yield = 98.0 percent
Residue = 1.0 percent
Losses = 1.0 percent

The fractional composition of the condensate shows that it is basically composed of naphtha that could not be separated more closely under refinery conditions because of faulty operation of the stripping column; an insignificant amount of heavy residues was condensed in the tail ends of the condensate. A cracked naphtha having the following properties was separated from this condensate in the laboratory:

Density at 20°C. = 0.814
Acidity = 0.88 mg.
Induction period = 150 min.
Octane number without Et_4Pb = 68

Engler distillation

I.B.P.	121°C.	
Boiling below	130°C.	1.5 percent
	140°C.	3.5 percent
	150°C.	10.5 percent
	160°C.	21.0 percent
	170°C.	41.5 percent
	180°C.	56.0 percent
	190°C.	71.0 percent
	200°C.	83.5 percent
	210°C.	91.5 percent
	220°C.	96.0 percent
Endpoint	224°C.	

Yield = 97.0 percent
Residue = 1.0 percent
Losses = 1.0 percent

According to the octane number, the obtained naphtha is far above all standards and is an excellent fuel for certain types of engines. The naphtha can be used alone or mixed with straight-run kerosines. The polymers obtained from the bottom of the zinc-chloride treating tower during the refining of the pressure distillate in the liquid-phase cracking with zinc chloride (for the purpose of obtaining a light gasoline) were obtained under refinery conditions in such small amounts that they were of no practical importance.

Material Balance

In the operation of the refinery-scale zinc-chloride treating process to manufacture light cracked gasoline having improved properties, the following material balance is obtained:

Pressure distillate used	100 percent
Light cracked gasoline obtained based on volume of pressure distillate	50.3 percent
Naphtha obtained	46.2 percent[6]
Losses, plus polymers, in refining	3.5 percent

Thus, more than 50 percent of a high-grade gasoline that will find widespread use in Russia is obtained from the pressure distillate by means of zinc-chloride treatment.

The following material balance is obtained when refining distillates with zinc chloride for the manufacture of motor fuel:

Pressure distillate used	100 percent
Motor fuel obtained	92.3 percent
Polymers in refining	4.9 percent
Losses in treatment	2.8 percent

A material balance of sulphuric-acid treatments shows that the yield of treated motor fuel before redistillation amounts to 97 percent and thereafter 73.7 percent based on the volume of pressure distillate distilled.

The material balance shows clearly the importance of the zinc-chloride method. Furthermore, attention should be drawn to the fact that the polymers obtained in the treatment with zinc chloride are not waste products as is, for example, the acid sludge from sulphuric-acid processes, but can be used by the plastic industry.

Conclusions

(1) The refinery-scale experiments on the refining of liquid-phase cracked pressure distillates with zinc chloride on a carrier have confirmed entirely previous favorable results of laboratory investigations.

(2) The operation of the unit has shown that by means of a zinc-chloride treatment, high-grade gasoline with an improved octane number can be obtained.

(3) The zinc-chloride treatment is carried out with a minimum of losses and byproducts.

(4) The zinc-chloride treated gasolines are stable after having been stored in tanks for 6 months.

(5) The zinc-chloride catalyst is available in large quantities and is quite stable during the treating process.

[6] As stated, naphtha could not be produced under refinery conditions because of faulty stripping column. In the laboratory, however, 98 percent naphtha of good quality was taken off the condensate. The amount was 46.2 percent of the pressure distillate.

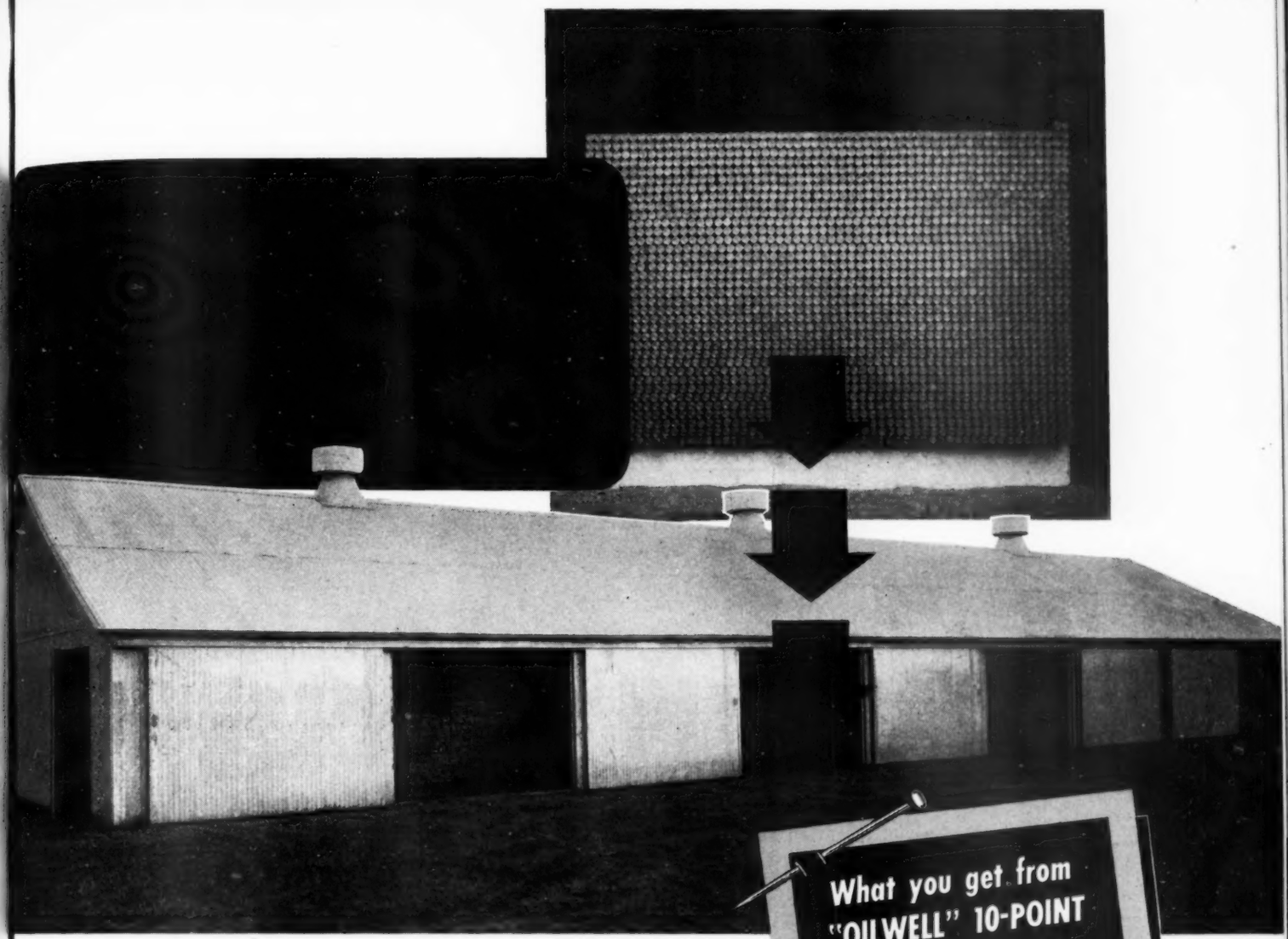
☆ ☆ ☆

Digest of Manpower Rules

A digest of manpower rules and regulations, with particular emphasis upon those dealing with petroleum, has been issued by the Petroleum Industry War Council's Committee on Manpower, William R. Boyd, Jr., Council chairman, announces.

The booklet outlines the laws and executive orders relating to manpower, and the current interpretations of the rules and regulations issued by the Selective Service, War Manpower Commission, and other government agencies under these laws and orders.

Subjects covered include the Selective Service procedure relating to occupational deferments, the replacement schedule and manning table plans, wage and salary stabilization rules, the minimum 48-hour work week, hiring controls, restrictions on transfer of workers, appeal procedures, and the manpower activities of PAW.



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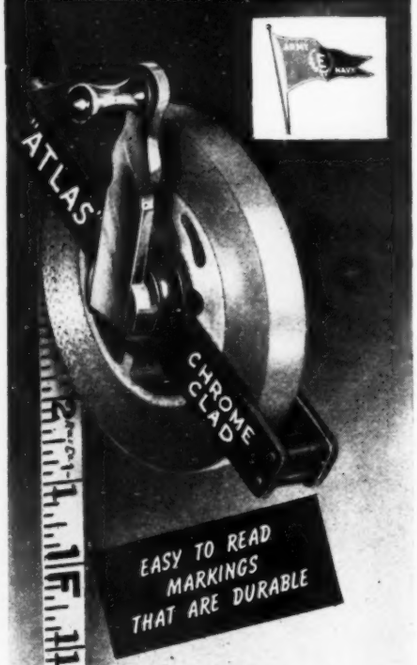

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FROM WASHINGTON

Amendment to Preference Rating Order P-98-b

Preference Rating Order P-98-b, under which the petroleum industry procures priorities assistance in obtaining materials, has been amended, effecting six important changes.

1. The Petroleum Administration for War is authorized by the War Production Board to issue, in its own name, further restrictions or limitations on the use of priorities assistance by operators in the petroleum industry.

2. Production operators must now file a copy of delivery orders on controlled materials, as well as on non-controlled, e.g., one copy of the delivery order must be filed, but approval by PAW is not required, where total cost of all items is less than $1000 and more than $100, with no single item $500 or more; two copies of delivery order must be filed and advance approval obtained, where total cost of all items is $1000 or more, or where any single item is $500 or more.

Compliance with this requirement will enable production operators to make full use of PAW's allotment of controlled materials for oil country tubular goods. Under the Controlled Materials Plan it has become increasingly necessary that the petroleum industry be able to take full—not just partial—advantage of PAW's controlled material allotments.

3. MRO materials to be used in retail marketing (service station) operations are restricted to an AA-5 priority rating, instead of the AA-1 rating formerly authorized. This change brings P-98-b into harmony with recent changes in CMP Regulation No. 5, which affects all retail distribution.

4. Materials used in petroleum research or technical laboratories, other than for construction of laboratory buildings or structures, are now classified as MRO materials and therefore carry a priority rating of AA-1. This change brings P-98-b into harmony with recent amendments to WPB Orders P-43 and L-144.

5. Participation in PAW Materials Redistribution Program No. 2 is now a prerequisite for the use of priorities assistance to obtain deliveries on and after August 1, 1943, if the operator is required by the terms of the Materials Redistribution Program to be a participant.

6. Schedule "C" of the former order, controlled by paragraph (c) (2), has been amended and the list of items formerly set forth under that schedule has been eliminated. In place thereof, the operator is referred to Priorities Regulation No. 3, paragraph (f) and Lists "A", "B" and "C", which now control.

The lists set forth in Priorities Regulation No. 3 consist of three groups of materials items:

"A"—those for which no preference rating is required.

"B"—those for which MRO ratings under P-98-b may not be used.

"C"—those for which specific preference ratings are given, or which may be obtained only by proceeding along lines set forth in specific WPB Orders, which are listed immediately alongside the item for which they are controlling.

The old Schedule "F" under P-98-b contained a list of items that could not be obtained by using preference ratings otherwise authorized under the order, but which required either special procedure or not preference rating at all. This list was necessarily incomplete and was subject to constant change as a result of the impact of the war program on various materials.

Under such circumstances, revision of P-98-b would have been required with every change affecting any of the items on old Schedule "C." By substituting reference to Priorities Regulation No. 3, paragraph (f), Lists "A", "B" and "C", petroleum operators need only keep abreast of changes in that regulation, which automatically becomes part of P-98-b.

Preference Rating Order P-98-c Amended

Preference Rating Order P-98-c, which deals with sales and exchanges of idle or surplus material among operators in the petroleum industry, has been amended by the War Production Board to bring it into conformance with the new Materials Redistribution Program No. 2, announced simultaneously by the Petroleum Administration for War.

The amended order also authorizes the Petroleum Administration for War to issue in its own name, additional restrictions or limitations on the use of priorities assistance by petroleum operators. This provision will aid the PAW in carrying out the administrative responsibilities delegated to that agency by the War Production Board with respect to this order.

Preference Rating Exclusion Order M-201 Amended

Preference Rating Exclusion Order M-201 has been amended by the War Production Board, adding four new items in the list of petroleum products for which preference ratings may not be used in obtaining supplies.

Naphtha, petroleum insecticide bases, petroleum wax and petrolatum (commonly known as petroleum jelly) are the four new products for which preference ratings may not be used. In addition, the definition of lubricating oil has been changed in the amended order to include oil that is used for, or is suitable for lubrication, including but not limited to, cutting, drawing, processing, soluble, transformer, and white oils, which do not contain in excess of 50 per cent by weight of additives or compounds.

Preference Rating Exclusion Order M-201 serves to prevent over-lapping and conflict between allocation programs handled by the Petroleum Administration for War and those of the War Production Board.

Applications for exceptions to the order shall be made to the Petroleum Administration for War on Form PD-1A, and accompanied by a letter in triplicate stating the reasons for exceptions.

Changes in Regulations for Eastern Areas

Amended Supplementary Order No. 2 to Petroleum Administrative Order No. 11, affecting production operations in Eastern Ohio, Eastern Kentucky, West Virginia, Pennsylvania, and New York, has been issued by the Petroleum Administration for War.

By the provisions of four important changes, the amended Supplementary Order:

1. Allows 5-acre spacing for oil wells to a depth not exceeding 1200 ft. in lieu of the former provision allowing this spacing to a depth of only 1000 ft.; 10-acre spacing for oil wells more than 1200 ft. deep but not exceeding 2500 ft., and 20-acre spacing for oil wells exceeding 2500 ft. in depth continues unchanged.

2. Permits the installation of pumping or other artificial lifting equipment on oil wells drilled to a depth of 2500 ft. or less, to which at least five productive acres can be attributed.

3. Extends the area covered by the Supplementary Order to that part of the State of Ohio, which is included in and which lies east of the counties of Lorain, Ashland, Richland, Knox, Licking, Fairfield, Hocking, Vinton, Jackson, and Lawrence, and to that part of the State of Kentucky, which is included in and which lies east of the counties of Lewis, Fleming, Bath, Kenifee, Powell, Estill, Jackson, Laurel, and Whitley.

4. Deletes the provisions for secondary recovery operations in certain parts of New York and Pennsylvania, as secondary recovery operations are now permitted anywhere in the United States under the provisions of Supplementary Order No. 6 as recently amended.

☆ ☆ ☆

NO OTHER DIESEL . . .

Logging, mining, marine, oil fields, construction, manufacturing and highway truck transportation . . . these are industries essential to a nation at work or a nation at war. In more than a decade of service—spanning both peace and war—these same essential industries have demonstrated that Cummins Diesel power is essential to maximum production at minimum cost.

It is a matter of record that no other American Diesel has ever served so many industries so long and so well. CUMMINS ENGINE COMPANY, Columbus, Ind.

MID-CONTINENT SUPPLY COMPANY • FORT WORTH, TEXAS

Distributors Mid-Continent Territory

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19 Rector Street, New York, N. Y.

General Heading: BAKER ROTARY WALL SCRAPER

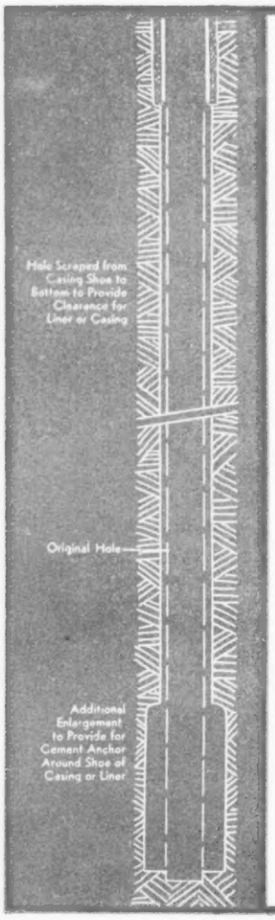
Unit No. A-30

Subject: Enlarging Hole to Provide Clearance for Liners

Index: 250.1
Date: August, 1943
Page: 1

Many operators when setting liners, prefer to run the largest possible liner down through the water string and in such a practice the matter of clearance becomes an important factor. To insure getting the liner to bottom safely without sticking, it has become standard practice in many fields to enlarge the hole from casing shoe to bottom with a Baker Wall Scraper.

Details of such an application are given below.


Hole Scraped from Casing Shoe to Bottom to Provide Clearance for Liner or Casing
Original Hole
Additional Enlargement to Provide for Cement Anchor Around Shoe of Casing or Liner

In the particular well illustrated at left, 8⅝" O.D. casing was set with 7⅝" drilled hole below the shoe. It was desired to run a 6⅝" O.D. threaded and coupled liner. The O.D. of the coupling on the liner being 7⅜" was a little too close for comfort to run in a 7⅝" hole. Accordingly, the hole was enlarged from casing shoe to bottom (1000 ft.) with a Baker Wall Scraper. The liner was run to bottom safely without danger of sticking.

For details concerning construction and operation of the Baker Wall Scraper see pages 279-287 of the 1942 Baker, or Composite, Catalog. Also send for Baker Broadcast No. 19, a 10-page illustrated treatise covering Baker Wall Scraper applications.

Product No. 500
Baker Rotary Wall Scraper

IMPORTANT APPLICATIONS

Enlarging Hole to Provide Clearance for Liners
Scraping Face of Producing Zone
Setting Cement Plugs
Water Shut-Off Tests
Straightening Holes
Enlarging Holes for Gravel Packing
Side Wall Sampling
(By converting Scraper into Baker Wall Sampler)

Competent Baker men will advise, make suggestions, and otherwise assist in securing best possible results.

LAUGH WITH BARNEY

"Sambo, you are late this morning. Any reason?"

"Yassah. When Ah looked into de glass dis mornin' Ah couldn't see maself dere. So Ah thought Ah must hab gone ter work. It was two hours after dat Ah discovers de glass had dropped out ob de frame."

* * *

Nurse (at insane asylum): There is a man outside who wants to know if any of the male patients have escaped lately.

Doctor: Why does he ask?

Nurse: He says somebody has run off with his wife.

* * *

Jim: Your dog looks smart.

Joe: Yeah, I say, "Are you coming, or aren't you?" and he either comes or he doesn't.

* * *

If he still has his appendix and his tonsils, 10 to 1 he is a doctor.

* * *

"But, officer, I didn't see that fire plug. When I parked here, it was hidden behind an airedale."

* * *

Marketing one day when the maid was off, the lady of the house came upon her servant wheeling a rickety carriage holding twins. "Whose babies are these?" "Mine," was the answer. "Yours? Why, I thought you were an old maid." "Well, I am, but I ain't a fussy old maid."

* * *

A certain friend was calling on a married woman.

"My darling," he breathed, "I love . . ."

At that moment the door bell rang. The woman jumped up. "My God!" she gasped, "it's my husband! You must get out, q-u-i-c-k."

"But how am I going to get out?"

The woman thought quickly, then whispered, "Jump out of the window, hurry!"

"But we're on the thirteenth floor."

She stamped her foot impatiently: "THIS is NO TIME to be *superstitious.*"

* * *

A couple of men who met in a Midwest city were making conversation as they walked along the street. As they chatted they passed the window of a fish store where row on row of cod, with glassy eyes staring sightlessly out at the crowd, were lying.

"Gee, Joe," blurted out one of the wholesalers. "Hafta excuse me, Old Man. I just remembered—I'm due right now to address a sales meeting."

Preacher: You should love your enemies.

Old Reprobate: Parson, I do. I love rum, tobacco and the horses.

* * *

Once a politician had merely to promise a new postoffice. Now he has to promise a new world.

* * *

"Is there any truth in the report that Angus MacTavish bought the corner filling station?"

"Well, I don't know for sure, but the 'free air' sign has been taken down."

* * *

"Where's the car, dad?" asked the son of an absent-minded professor.

"Why, dear me, I really don't know," he said, scratching his head in an effort to recall the past. "Did I take it out?"

"You certainly did, you drove it downtown this morning."

"Well, now, that is quite remarkable," said the professor. "I remember now that after I got out I turned 'round to thank the gentleman who had given me the lift and wondered where he had gone."

* * *

Landlady: "You've been here two years and never complained," she said to her rube boarder. "What are you leaving for now?"

Rube Boarder: "I just found out you ain't got no bathtub."

* * *

She: "Say, it's past midnight. Do you think you can stay all night?"

He: "Gosh, I'll have to telephone mother first."

* * *

Professor: "Jones, what would you say is the most effective agency for redistribution of wealth?"

Jones: "The wives, daughters, and sons of rich men."

* * *

"Darling, haven't I always given you my salary check on the first of every month?"

"Yes, but you never told me you get paid twice a month, you embezzler."

* * *

The Gob on furlough and his bride came embarrassedly into the hotel, and after a whispered huddle, she went up to the clerk and asked for a room and bath. They registered; and the clerk eyed their lone piece of baggage.

"Have you only an over-night case?" he inquired.

"Don't get fresh," snapped the bride, "we're going to stay a week."

* * *

The next generation of youngsters is bound to be an improvement because they'll all be from registered fathers.

STOODY 6
Applied by Welding Reclaims Worn Valves

NOW worn valves, valve parts and pump sleeves can be reconditioned to outperform new factory parts by a simple oxyacetylene welding application using Stoody 6. This new Stoody alloy, composed principally of cobalt, chromium and tungsten, will not oxidize—even under intense heat, has high impact strength in relation to its hardness, offers excellent resistance to abrasive wear, and is perhaps the easiest of all hard-facing alloys to apply. Stoody 6 is highly efficient for hard-facing new or old internal combustion exhaust valves, gate, globe and angle valves, hot oil pump sleeves, etc.

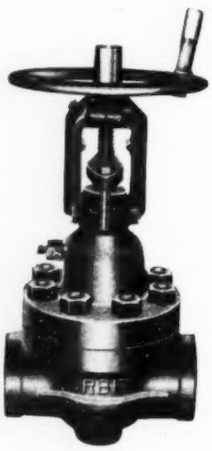
Trial order of 10 lbs. of 3/16" diameter Stoody 6 at $4.25 per lb. will prove the merits of this alloy for any applications involving heat, corrosion, abrasion and impact. Available on AA-4 or higher priority rating.

STOODY COMPANY
1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear . . . Eliminate Repair

ORBIT VALVES

ARE BUILT TO "TAKE IT"



ORBIT FLOW LINE VALVE

A full round opening valve that operates easily under high pressures. No grease required to effect a seal. Compact in design, yet built to "take it."

●

YOUR ORBIT VALVES will last for the duration. Meanwhile, if you have any questions regarding their care or maintenance, write us.

●

OIL WELL IMPROVEMENTS CO.

Since 1912

TULSA, OKLAHOMA

Running Tour

WITH MEN IN THE INDUSTRY

S. L. CRONIN, head of the Pure Oil Company's land department for many years, died at El Dorado, Arkansas, July 28. He had retired from Pure Oil Company in 1938 after 38 years' service.

STEWART P. COLEMAN, on leave from Standard Oil Company of New Jersey, where he is head of department of economics, has been appointed head of a new program division in the Petroleum Administration for War. The newly created section will have the object of coördinating PAW activities with special attention to the problem of supplying adequate oil and motor fuel to meet military demands. Coleman, a native of Corpus Christi, Texas, holds degrees from Rice Institute and Massachusetts Institute of Technology. He has had 20 years' experience in the oil industry, the last two of which he has served with PAW when he was granted leave of absence by Standard.

RALPH J. CORDINER has been appointed assistant to the president of General Electric Company, it is announced by Gerard Swope, president. Cordiner, who resigned in July as vice-chairman of the War Production Board, was formerly president of Schick, Inc., of Stamford, Connecticut, and prior to that was manager of the appliance and merchandise department of General Electric Company. A graduate of Whitman College, Walla Walla, Washington, in 1922, Cordiner has been closely associated with selling of electrical appliances since that time.

FRED M. YOUNG is a new vice-president and member of the board of directors of Western Metals Specialty Manufacturing Company, Milwaukee, Wisconsin, it is announced by Alma E. Goetz, president. Young has for many years been president and general manager of the Young Radiator Company of Racine, Wisconsin, and his major activity will continue with that company.

E. A. BROWN has been appointed general superintendent for Ashland Oil and Refining Company, Ashland, Kentucky. He succeeds BOYD MORGAN who was fatally injured several weeks ago.

THOMAS D. BAILEY has been named petroleum engineer in the Oil and Gas Conservation Division of the Oklahoma Corporation Commission. A graduate of Oklahoma University, Bailey has been employed as engineer with the Arkansas Oil and Gas Commission and has been connected with Stanolind Oil and Gas Company. He resigned the latter position to accept the new post.

C. T. FOSTER, assistant to the president of The Standard Oil Company of Ohio, has also been appointed manager of the company's department of industrial relations, filling the position formerly occupied by DR. W. P. EDMUNDS, it was announced by W. T. HOLLIDAY, president. His new responsibilities will be in addition to his present duties as assistant to the president. Foster, who was born in Cleveland, is a graduate of Western Reserve University, and was connected with the law office of Friebolin and Byers before entering the Standard Oil organization in 1929.

MARION T. GLASS, 55, superintendent of the Union Producing Company Land and Lease Department, died July 17 at his home in Shreveport, Louisiana. He was born September 22, 1887, in Marion County, Texas. Having had previous experience in the oil industry, Glass joined a predecessor company in 1927 as a land man. He became head of the land department in 1932.

F. M. (JERRY) SIMPSON of Bartlesville, Oklahoma, is the new general superintendent of the refining division of Cities Service Oil Company. Simpson, who has been with Cities Service the last 20 years, succeeds W. W. SCHEUMANN, who is now associated with Cities Service Refining Corporation. In his position, Simpson will supervise operations at Cities Service Oil Company's refineries at East Chicago, Indiana, and Ponca City, Oklahoma.

After he was graduated from Texas A. and M. College with a B.S. degree in mechanical engineering, Simpson became a junior engineer for a predecessor company to Cities Service Oil Company. He worked at the Ponca City refinery for two years before joining the headquarters staff of the refining division, then at Tulsa. He moved to Bartlesville in 1940 when the division offices were transferred there.

TOM C. SHAW has been named to head the engineering and operations department of Anchor Petroleum Company, Tulsa, Oklahoma, in a recently announced expansion program. Anchor is a producer and marketer of butane and propane. A native Texan, Shaw has been a Tulsa resident for two years, being associated with the Standolind Oil and Gas Company. Previously he was in charge of manufacturing for the Coronado Corporation, Corpus Christi.

TOM C. SHAW

L. L. BRUNDRED has resigned his post as general manager of sales, Spang Chalfant, Inc., Pittsburgh, Pennsylvania. He left the company July 15 to reenter the oil business.

T. H. WILLIAMS, with the District 7-C office of the Gas and Oil Division, Texas Railroad Commission, at San Angelo, Texas, has been appointed deputy supervisor, it is announced by Beauford H. Jester, commission chairman. Williams will assume his new duties September 1.

JAMES TANHAM, New York, vice-president of The Texas Company, has been appointed an alternate industry member of the National War Labor Board. He has served as a panel member representing industry in many WLB cases. Employed by The Texas Company for 25 years, he started as a stenographer and has been vice-president since 1941.

GEORGE F. SMITH, vice-president of Continental Oil Company, has retired after 36 years with the organization. Smith joined Continental Oil Company in 1907 as an accountant in Denver. He was made assistant secretary and assistant treasurer in 1912, served as director from 1913 to 1929, and was elected secretary and treasurer in 1919. He was elected vice-president in 1937.

O. L. FISHER has been named general superintendent of Continental Oil Company's Gulf Coast Division, Production and Drilling Department, to succeed FRED F. WALTERMIRE. Fisher joined Continental in 1926 as a clean-out helper in the Production Department, Panhandle District, Texas. In 1935, he was named district superintendent at Basile, Louisiana, and in 1941, was promoted to assistant division superintendent, Houston. Fisher's headquarters will remain at Houston.

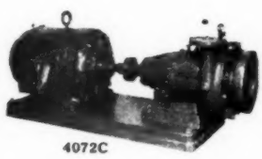
J. Q. MCGIFFIN is now associated with General Tire and Rubber Company in its Synthetic Rubber Division at Baytown, Texas. At the time he presented the paper, "Crude Naphtha Stabilizer Performance," which was published in *The Petroleum Engineer's* Reference Annual (July 1), McGiffin was connected with the Latonia Refining Corporation, Latonia, Kentucky, subsidiary of Standard Oil Company of Ohio.

J. Q. McGIFFIN

FRED (PETE) WALLACE of the Link Belt Company, Indianapolis factory, spent about a month recently visiting fields in the Mid-Continent and Gulf Coast areas. He was able to spend some time with his many friends in Tulsa, Oklahoma City, Dallas, and Houston.

VICTOR HOWARD BORSODI, 57, one of the founders of the Humble Oil and Refining Company and one of the largest oil operators in the country, died July 13 at his home in San Antonio, Texas. He was associated with Jesse Jones and the Sun Oil Company.

CENTRIFUGAL PUMPS RECIPROCATING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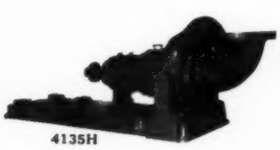
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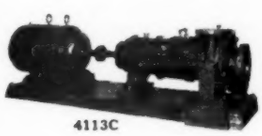
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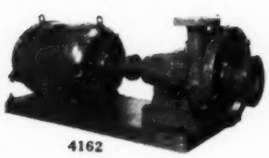
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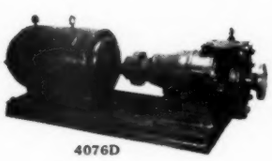
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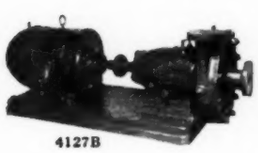

4127B

The national synthetic rubber production is expected to reach over 240,000 tons at the end of 1943.

Our centrifugal pump is on the job in several different plants helping make this production possible.

Cuts are photographs of a few of the different pumps of which we have many duplicates that are operating at this time in synthetic rubber plants.

We are proud to be participating in something so vital to our war effort.

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W. TENTH ST.

MACHINERY and EQUIPMENT

Staynew Sump Type Liquid Filter

FOR the first time, the Staynew Radial Fin Construction has been applied to a sump type liquid filter. Designed for use wherever dirty liquids are collected, filtered, and re-circulated, the Model SE Staynew Sump Type

Liquid Filter meets the demand for a compact, simplified, efficient filter unit that can be mounted on the end of pump suction lines and completely submerged in the settling basin or sump from which the pump obtains its liquid, according to the manufacturer. An installation of this type protects the pump from abrasive particles that cause rapid wear and at the same time provides clean liquid at various points of usage. It prevents build-up of sludge, cuttings, sand, etc., in hydraulic systems, thus permitting less frequent inspections and cleanouts, it is stated.

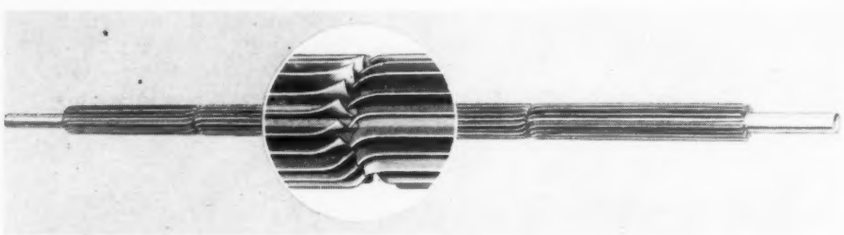
The Model SE Sump Filter's Radial Fin Insert is said to provide a maximum of effective filtering area in a minimum of space. As a result, there is less resistance to flow.

As a result of field tests, a relatively hard finish filter medium was developed, capable of handling liquids of relatively high viscosity carrying heavy concentrations of metallic cuttings, abrasives, sludge, etc. It is particularly well adapted to filtering sulphurized and straight mineral oils and water soluble oils that are commonly used as coolants. This material is pre-formed in a radial fin shape and slips over a heavy similarly shaped mesh supporting form. This design permits expansion of the insert like a bellows so that accumulated material may be washed or brushed off and the medium restored to its original condition within a very few minutes. It makes insert replacements inexpensive.

Simplicity of construction permits dismantling of the unit without removing it from the pump suction line, if desirable. There are but four major parts: An upper end plate mounting a threaded sleeve outlet connection and a perforated metal central supporting tube on which is mounted the filter insert; a heavy corrugated metal screen to supply strength and rigidity, over which slides the pre-formed filter insert; a lower end plate. A wing nut holds the entire assembly together.

Brown "Cut and Twisted" Fintubes

THE Brown Fintube Company of Elyria, Ohio, manufacturers of Brown resistance-welded, integrally-bonded fintubes, one lineal foot of which is said by the makers to provide the heat transferring capacity of from 6 to 10 ft. of plain bare tubes, has now added "cut and twisted" fintubes to its line.

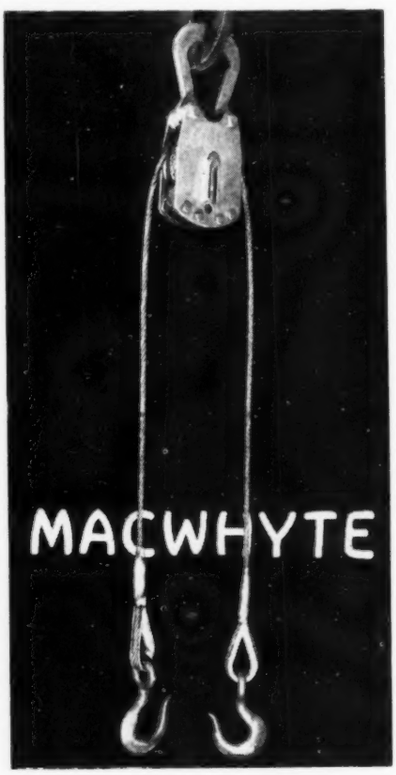


This new development, according to company officials, consists of taking standard types of Brown "longitudinal" fintubes, cutting the fins transversely at desired intervals, and twisting the ends. (See illustration).

This cut and twisted fin is said to produce greater turbulency of the shell side commodity than when straight untwisted fins are used—and produces increased thermal efficiencies ranging up to 50 percent in Sectional Hairpin and other types of heat exchangers in which the shell side commodity is held closely against the fintube, resulting in still further savings in weight, pressure drop, shipping, etc.

New "Level-Lift" Sling

A NEW sling recently announced by Macwhyte Company after a thorough trial is called the Macwhyte Caldwell "Level-Lift" type C S E Sling. A single unit handles 3 tons, a double unit handles 6 tons with a safety factor of 5, the manufacturer states.



The sling has a special patented feature that enables the rope to equalize itself and lift unbalanced loads level. Users say it is simple, easy to use, saves time and labor especially in handling long pipes, boxes, steel, and flasks, according to the makers.

It is made in one size for handling loads up to 3 tons using one unit, or loads up to 6 tons when used in pairs. Manufactured by Macwhyte Company, Kenosha, Wisconsin.

WAR TIME ELECTRIC SERVICE AND WHAT IT MEANS TO YOU!

WAR has made great demands on UTILITY ELECTRIC POWER, a fact you know already. That's why, at this time, your Electric Power Service Company may not be able to grant requests for power for non-war usage. But there is an important factor in your favor in that the war is providing your UTILITY ELECTRIC POWER COMPANY with invaluable experience—an experience that will definitely result in greater ELECTRIC POWER SERVICE for you. So when the time comes to turn this tremendous force of power back to regular operations the petroleum industry will be among the first to enjoy the benefits of greater UTILITY ELECTRIC POWER SERVICE. In the meantime, let's keep our "shoulders to the wheel" and do everything to win this war as quickly as possible.

Use Utility Electric Power!

PETROLEUM ELECTRIC POWER ASSOCIATION

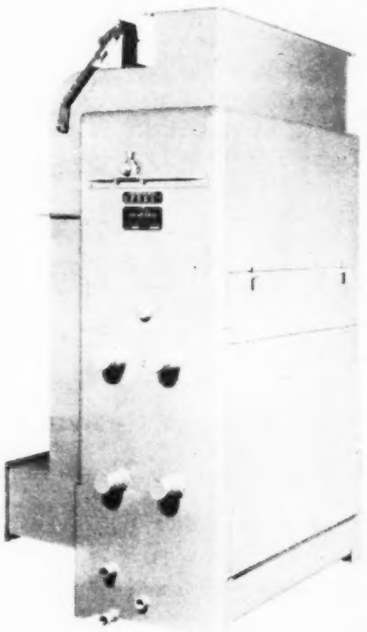
Box 1498, Oklahoma City, Oklahoma

Heat Exchanger Development

A NEW development for adding heat to industrial liquids for the purpose of maintaining constant temperatures as desired, with automatic control, is announced for the Niagara Aero Heat Exchanger. This has not been previously done with the evaporative type liquid cooling unit using a water spray and fans to draw air over coils containing the liquid whose temperature is to be controlled, according to the manufacturer. This is accomplished by using either a steam coil or injector or an electric heating unit to heat the spray water. U. S. Patent No. 2,321,933 has recently been granted on this equipment.

The result is control of liquid temperatures within prescribed limits, alternately cooling or heating as required. The heating device is put into operation by thermostatic control at the desired point, preventing the liquid from becoming too cold for the process in which it is used, or from becoming viscous with retarded flow and loss of capacity, or from congealing or freezing. This also makes it possible for the heat exchanger to be successfully installed out-of-doors, or to use fresh, out-of-door air to increase its evaporative cooling capacity and avoid damage from handling air containing corrosive substances.

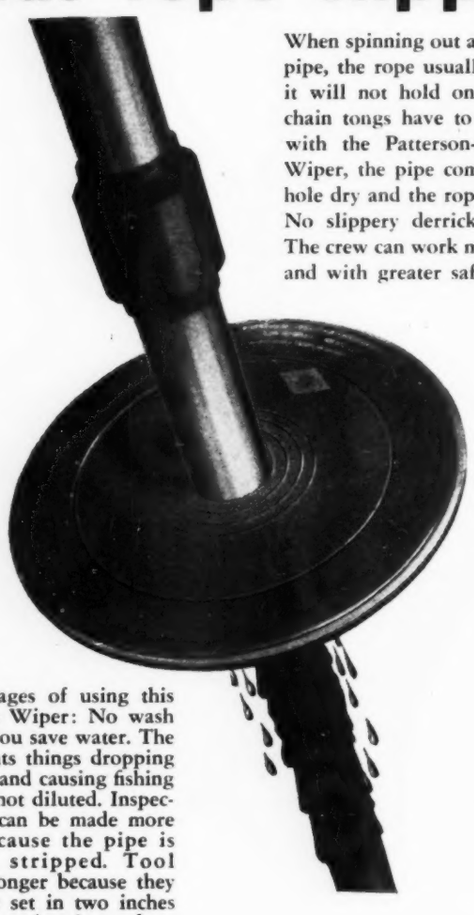
The heat exchanger with these features is used to control temperatures in



industrial chemical process and electrical equipment by controlling jacket water temperatures, also quenching baths in the heat treating of metals, cutting oils and lubricants in metal working, machining and wire drawing, controlling temperatures of chemical process liquids in many fields, and engine jacket water. It is also applied to air and gas compressors. It is manufactured by Niagara Blower Company, 6 East 45th Street, New York, 17, New York.

Pipe Wiper avoids rope slippage

When spinning out a stand of drill pipe, the rope usually gets so wet it will not hold on the pipe, so chain tongs have to be used. But with the Patterson-Ballagh Pipe Wiper, the pipe comes out of the hole dry and the rope doesn't slip. No slippery derrick floor either. The crew can work more efficiently and with greater safety.



Other advantages of using this effective Pipe Wiper: No wash water used. You save water. The Wiper prevents things dropping down in hole and causing fishing jobs. Mud is not diluted. Inspection of pipe can be made more carefully because the pipe is thoroughly stripped. Tool threads last longer because they don't have to set in two inches or so of mud on the pipe rack.

PATTERSON-BALLAGH PIPE and TUBING WIPER

PATTERSON-BALLAGH CORP. . . Los Angeles, Houston, New York City

Raw Material For Synthetic Elastomers

A NEW raw material that offers interesting possibilities in the development of synthetic elastomers has been made available by Reilly Tar and Chemical Corporation, Indianapolis, Indiana. The new chemical, developed in the Reilly Laboratories, research division of the Reilly organization, is 2-Vinylpyridine, which is the pyridine analog of styrene.

According to Reilly chemists, 2-Vinylpyridine copolymerizes similarly with butadiene and styrene, and with butadiene and styrene together, to form a synthetic elastomer that is said by rubber experts to have very interesting properties. The material boils at 159°C. (760 mm.) and can be distilled at about

98°C. at 100 mm. It is soluble to the extent of about 2.5 percent in water and is readily emulsified with water, about 15 percent of the water dissolving in it.

Reilly officials announce that the company is now in production on 2-Vinylpyridine, and that the Reilly technical staff will be pleased to consult and cooperate with producers interested in investigating the possibilities of the new material as a modifier in the copolymerization of styrene and butadiene, also in the manufacture of elastomers for specialized uses.

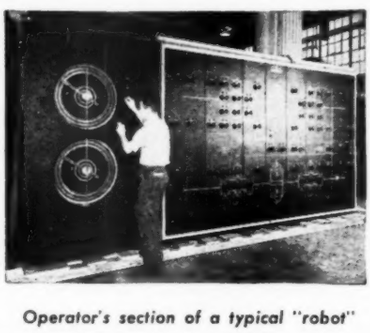
"Robot" Control

A "ROBOT" control that opens and closes dozens of valves with split-second timing now controls processing in many of the nation's plants producing aviation gasoline, butadiene for synthetic rubber, and toluene for explosives, according to B. M. Mills, of the petroleum and chemical section of General Electric Company's Industrial Engineering Department.

In such plants steam, air, and hot gases flow intermittently through a complex system of piping and tanks. These gases must follow each other at predetermined intervals, and any error in timing or route of flow would slow up production not only through loss of materials but possible damage to equipment.

"The processing might be compared to the job of scheduling, dispatching, and regulating trains on a congested railroad system," Mills said. "One small error can tie up railroad traffic for hours, possibly resulting in collisions which would damage both trains and goods in transit.

"The General Electric 'robot' control performs the same functions in gasoline, butadiene, and toluene plants as dispatchers and switchmen do in a railroad system. In many of these plants, even if required numbers of skilled operators were available, it would be humanly impossible for them to open and close the numerous valves with the precise timing provided by the 'robot' control, consisting of automatic cycle-timers and valve control.



Operator's section of a typical "robot"

"The 'robot' controls the flow with machine-like precision, minimizing the possibility of human error. If something goes wrong, such as a valve sticking open or shut, the control even voices a warning—it summons an operator by blowing a horn, or ringing a bell."

The operator's section of the "robot" consists of a long control panel somewhat resembling the main switchboard in a telephone exchange. Covered with banks of switches, dials, lights, and other indicators, it is the focal point for valve control. When a valve is opened or closed, a light on the board goes on. If any valve should fail to open or close, the board would automatically suspend further operations and sound the alarm for an operator. A glance at the board would give the operator the trouble location and he could arrange for quick repairs.

Before the war this equipment was developed principally to produce high-octane gasoline for planes and cars. Because the same methods may be used in producing butadiene and toluene, the robot is now widely used in these two types of plants as well. Plans for extension to other types of plants requiring precise timing or valve control are also under way.

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STANDARD FOR PERFORMANCE

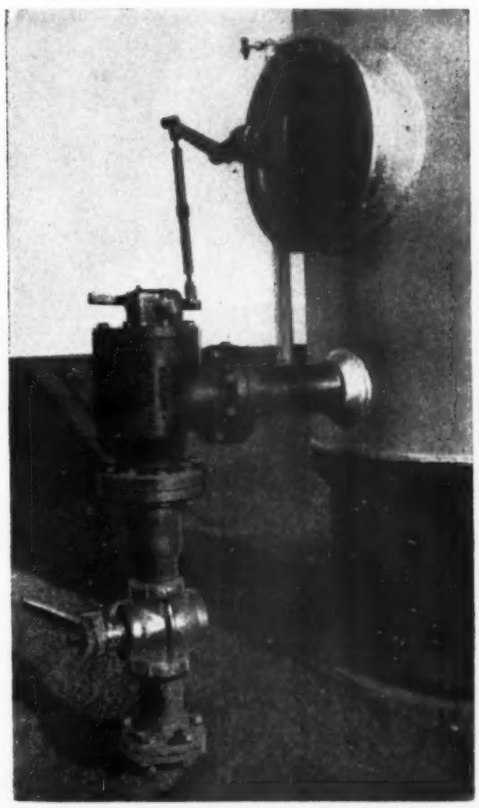
Oil & Gas SEPARATORS

Features HIGHLY EFFICIENT SEPARATION

- Both Standard and API-ASME Code Construction in 125 lbs., working pressure.
- API-ASME Code Construction for all vessels above 125 lbs., W.P.
- Lowest Maintenance Cost.
- Highest quality accessory valve equipment, H-W designed and manufactured.

FEATURING REMOVABLE SEAT RING ASSEMBLY in 125-lb. FLANGED ANGLE SERIES 800 OIL VALVES, both lever and diaphragm actuated. Valve port size in 4" valves can be reduced to 2" double or single port, if higher pressures are to be maintained on Separator and oil level assured in vessel.

All Pilot Control Accessories assembled on Type 301 Panel for 125 lbs., W.P. and Type 302 for 250 lbs. and above, where gas operated level control is utilized.



Photograph shows detail of 4" F.A. Type 820 Oil Valve, 4" screwed by 4" Flanged Type 403 C.I. Spool, 14" Type 625 Float Flange with Type 575 "Hi-Power" linkage.

Stocks at: TULSA, HOUSTON, WICHITA FALLS, BRECKENRIDGE, ODESSA, CORPUS CHRISTI, Texas; SHREVEPORT, Louisiana, CASPER, Wyoming

Information on all HANLON-WATERS Equipment available at representative nearest you

HANLON-WATERS, INC.

TULSA, OKLAHOMA

New York, Chicago, Pittsburgh, Philadelphia, St. Louis, Denver, Los Angeles
Shreveport, La., Fort Worth, Houston, Corpus Christi, and Odessa, Texas

Wallace Wilson Forms New Corporation

Wallace D. Wilson, president of Wilson Supply Company, has announced the formation of the Wilson Foundry and Machine Company, a corporation with the following officers: Wallace D. Wilson, president; T. W. Wilson, vice-president; R. W. Jeffrey, secretary-treasurer. The new corporation has purchased the properties, including machine shop and foundry, of the J. D. Nixon Company, situated in the 1400 block of Elysian Street, Houston, Texas.

The Wilson Foundry and Machine Company will manufacture the (patented) Nixon Surface Control Gas-Lift System and other oil-field specialists that were produced under the former ownership. Sales of all their products will be handled by Wilson Supply Company.

W. J. Sutton, petroleum engineer, for the last several years in charge of the petroleum engineering department and director of gas-lift sales for Wilson Supply Company, has been placed in charge of the new company. He will retain his position with the Wilson Supply Company, in addition to his new duties.

J. D. Nixon, former owner of the shop and foundry, has opened offices in the M. and M. Building, Houston. He and his staff of engineers will continue research and development in the field of gas-lifting for the new company.

The Wilson Foundry and Machine Company plant is one of the largest and most up-to-date in the Gulf Coast area. For the last year in addition to their usual products, the plant has been manufacturing many items for the Navy and government war agencies.

Pipe Line Service Appoints Jack Finney

Jack H. Finney, of 3448 Locke Lane, Houston, Texas, has joined the Pipe Line Service Corporation of Franklin Park, Illinois, as sales representative in the Mid-Continent area. In this capacity

JACK H. FINNEY

he will serve the industry from Houston, utilizing the company's complete pipe coating and wrapping facilities at its plants at Longview and Corpus Christi.

Finney has had extensive experience in the oil fields, having served as district manager in West Texas for Dowell, Incorporated, of Tulsa, Oklahoma, for the last eight years.

Scarritt Appointed Sales Manager

E. W. Scarritt has been appointed sales manager of Elgin Softener Corporation, Elgin, Illinois.

Scarritt graduated from the University of Illinois in 1925 with an M.S. degree in chemical engineering and chemistry. After research work in water conditioning at the University under Professor A. M. Buswell, he has been identified in this field for 18 years. A recognized chemical engineering authority, he has advanced many notable contributions to the science of water treatment and purification. A vice-president of Elgin Softener Corporation, he has been associated with this company since 1927.

RUBBER PRODUCTS

AVAILABLE IN STOCK

V-BELTS

MULTIPLE DRIVE BELTS — MATCHED SETS

PARTIAL LIST OF SIZES

Belt Sizes A WIDTH	Belt Sizes B WIDTH	Belt Sizes C WIDTH	Belt Sizes D WIDTH
A-26	B-42	C-51	D-120
A-31	B-46	C-60	D-128
A-35	B-51	C-68	D-144
A-38	B-55	C-75	D-158
A-42	B-60	C-81	D-162
A-46	B-68	C-85	D-173
A-51	B-75	C-90	D-180
A-60	B-81	C-96	D-195
A-68	B-85	C-105	D-210
A-75	B-90	C-112	D-240
A-80	B-97	C-120	D-270
A-85	B-105	C-128	D-300
A-90	B-112	C-144	D-330
A-96	B-120	C-158	D-360
A-105	B-128	C-162	E WIDTH
A-112	B-144	C-173	E-180
A-120	B-158	C-180	E-195
A-128	B-173	C-195	E-210
	B-180	C-210	E-240
	B-195	C-240	E-270
	B-210	C-270	E-300
	B-240	C-300	E-330
	B-270	C-330	E-360
	B-300	C-360	

IMMEDIATE DELIVERY

RUBBER BELTING

HEAVY DUTY — SILVER DUCK — SQUARE EDGE

A.P.I. SPECIFICATIONS

Furnished in All Required Lengths

Width Ply	Width Ply
8" x 6	14" x 6
10" x 6	16" x 6
12" x 6	18" x 6

(Other Sizes Available)

RUBBER HOSE

All Types and Sizes for Use on

LOADING RACK, OXY-ACETYLENE WELDING, COMPRESSORS, STEAM, OIL, SUCTION, WATER, FIRE, PAINT, ETC.

FORMATION TESTER PACKER ELEMENTS

see page 576 Composite Catalogue

Furnish Details of Your Requirements . . . Prompt Quotations . . . Immediate Deliveries

CARLYLE RUBBER CO., INC.

62-64 PARK PLACE • NEW YORK 7, N. Y.

Wheatley Brothers Change Firm Name

The recent change in the name of a pioneer oil country firm to Frank Wheatley Pump and Valve Manufacturer at Tulsa, Oklahoma, recalls that 27 years ago, two brothers, Tom and Frank Wheatley, opened a small repair shop in the back end of a garage in Kansas City, Missouri. From this obscure beginning, a quarter-century ago, developed Wheatley Brothers Pump and Valve Manufacturers.

From an original capital investment of virtually nothing, the firm has developed into a large, modern manufacturing plant, making a complete line of pipe-line supplies in addition to important war equipment for the U. S. Army and Navy. This progress is evidence of the many years of broad experience in all types of mechanical repairs and machine design that Tom and Frank Wheatley brought with them when they combined forces in 1916 under the corporate name of Wheatley Brothers.

By 1926, the company had become known in the Mid-Continent oil country for its ability to make or repair any pipe-line equipment. Wheatley equipment, designed for specific jobs under difficult operating conditions, increased in customer demand. In this same year, recognizing the growing demand in this area for their products, Wheatley Brothers established a plant in Tulsa, Oklahoma, and Tom Wheatley moved to Tulsa to take charge of the new operations.

Frank Wheatley, president of the firm, remained in Kansas City until 1934 at which time he purchased his brother's interest, assumed responsibility for the operation of both plants, and changed the corporate name to Wheatley Brothers Pump and Valve Manufacturers. Tom Wheatley moved to Houston, Texas, and organized a supply company to handle Wheatley products. The Kansas City plant was closed in 1936 in a move to centralize all operations in Tulsa.

With the change, Charles Wheatley leaves the company to organize a sales company in Tulsa to handle the sale of the Wheatley products.

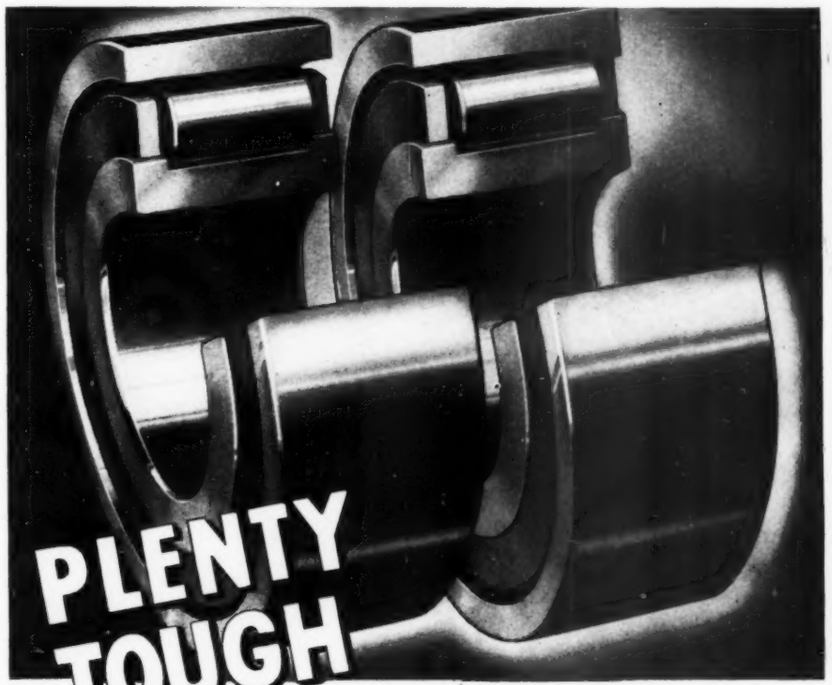
Since the beginning of the war the company has considered it a duty to take care of America's needs first if its customer requirements and its own facilities were to exist after the war. Officials of the company state they have considered it a privilege to manufacture important special materials for the United States Army and Navy and the War Emergency Pipeline, Inc.

At the same time the firm produced its full line of pipe-line equipment and supplies. Their customers, experiencing delays in shipments from the Wheatley plant, knew that it was only because the critical requirements of the armed forces came first.

The production of these vitally needed war materials, on which the contracts have now been completed, was facilitated greatly by the use of machine tools purchased expressly for that purpose. As a result of these added tools and of recent plant expansion, Frank Wheatly Pump and Valve Manufacturer are now in a position to make faster deliveries on almost all products, company officials state.

Lackens Heads N.I.A.A.

Frederick I. Lackens, advertising manager of the Hays Corporation, Michigan City, Indiana, manufacturers of combustion instruments and controls, has been elected president of the National Industrial Advertisers Association, Inc. Lackens is widely known in advertising and industrial circles, having been connected intimately with both since before the first world war. His new duties as president of N.I.A.A. will not disturb his connection with the Hays Corporation.



There is an adaptable, durable, reliable, easy-going AMERICAN RADIAL ROLLER BEARING for almost every heavy duty application where the load is radial. Because they are designed to exacting engineering standards . . . are constantly inspected and precision tested for absolute accuracy . . . AMERICAN RADIAL ROLLER BEARINGS render smooth, continuous service under the most rigorous operating conditions. Lower maintenance costs and increased performance-life of heavy machinery and equipment result.

AMERICAN RADIAL ROLLER BEARINGS are made in 5 styles, 4 S.A.E. series and 85 sizes. Special designs to order are also available. Consult our engineering department freely on all your roller bearing problems.

AMERICAN ROLLER BEARINGS HEAVY DUTY

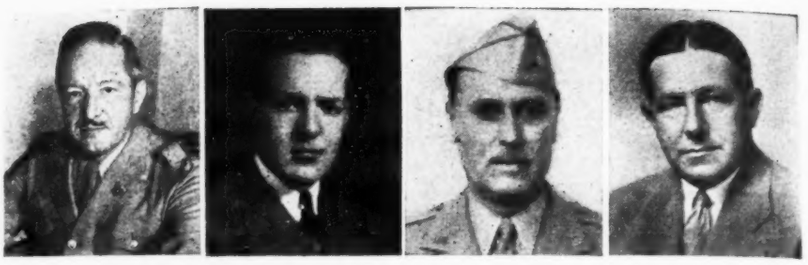
AMERICAN ROLLER BEARING CO.
PITTSBURGH PENNSYLVANIA
Pacific Coast Office: 1718 S. Flower St., Los Angeles, California

AMERICAN
Heavy-Duty ROLLER BEARINGS

Meter Company Executives Serve Country

Four of the top executives of the Pittsburgh Equitable Meter Company, Pittsburgh, Pennsylvania, are now active participants in various branches of governmental service.

Colonel Willard F. Rockwell, president, who has been in the Army Reserve more than 20 years, has been serving as Director of Production for U. S. Maritime Commission in Washington, D. C., since April 7, 1942. He was appointed to this post on the recommendation of General Knudsen and at the request of Admiral Emory S. Land, chairman of the commission. In this capacity, he is in charge of the production requirements for cargo vessels ordered by the commission and must see that schedules are maintained. He is a member of the Executive Committee of the Army and Navy Munitions Board, the Material Requirements Committee and Scheduling Committee of the W.P.B., as well as serving on numerous other committees.

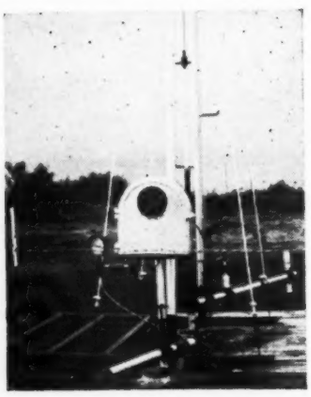


COL. W. F. ROCKWELL W. F. ROCKWELL, JR. MAJOR A. E. HIGGINS ALLEN D. MacLEAN

Allen D. MacLean, vice-president and chief engineer, is also in Washington with the Maritime Commission serving as assistant director of production.

Private W. F. Rockwell, Jr., vice-president and comptroller, is in training at the Army Ordnance Officers' School, Aberdeen Proving Grounds, Aberdeen, Maryland.

Captain A. E. Higgins, vice-president and sales manager, a reserve officer of many years standing, was on May 8 commissioned a major and assigned to active duty with the U. S. Air Corps.



Install NIXON Surface Control Gas-Lift

for lower production costs.

You'll save on the original purchase price . . . you'll save on installation cost . . . you'll save on operating costs . . . you'll have very little, if any, maintenance expense.

You'll be able to produce from high or low fluid levels . . . flow large or small volumes . . . deplete the well without changing or adding to the original installation.

Nixon Gas-Lift Systems are available for immediate installation. Get all the facts about its efficient and economical operation. Write your nearest Wilson Supply Company store or sales office.

WILSON SUPPLY COMPANY
1412 MAURY STREET — HOUSTON, TEXAS

SALES OFFICES:
Tulsa, Oklahoma; Dallas, Texas

LOS ANGELES: Western Pressure Control Co., 5700 Santa Fe Avenue.

TRINIDAD, B.W.I.: Neal Massey Engineering Corporation.

BRANCH STORES:
TEXAS—Gladewater, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi.
LOUISIANA—Lake Charles, New Iberia, Harvey, Shreveport.
ARKANSAS—Magnolia

Stubblefield Moves Up

Buford M. Stubblefield has been appointed superintendent of the Brier Hill Works of The Youngstown Sheet and Tube Company, succeeding A. S. Glossbrenner, who is now general superintendent of the Youngstown district plants.

B. M. STUBBLEFIELD

Stubblefield was born in McLean, Illinois, September 13, 1892.

He graduated from the University of Illinois in 1915, and in the summer of the same year moved to Youngstown to take a position with The American Tar Products Company.

In 1916 he entered the employ of The Youngstown Sheet and Tube Company at the Campbell Works Coke Plant; in 1920 he became assistant superintendent of the Coke Plant, and in 1923 was made superintendent. In March, 1929, he was made superintendent of the Coke Plant and Blast Furnaces at Campbell Works.

Advertising Department In New Location

Worthington Pump and Machinery Corporation, Harrison, New Jersey, announces that its advertising department is now located at 744 Broad Street, Newark 2, New Jersey. Contact by telephone can be made by calling Mitchell 2-0125.

Adin L. Davis, recently appointed advertising manager, heads the department and will direct all advertising, sales promotion, and publicity activities for the corporation.

W. F. Sewart Promoted

Dean Rollans, vice-president in charge of sales, Wickwire Spencer Steel Company and its subsidiary, the American Wire Fabrics Corporation, has announced the appointment of W. F. (Bill) Sewart as assistant sales manager of the Hardware Products Division.

Sewart has been with the company since 1923 and until 1932 was a sales correspondent in its export department. Since this time he has been active in the domestic sales of the company's hardware, manufactured for distribution through the hardware jobbing trade.

Sewart is especially familiar with the trade in the eastern states and in the Chicago area. He will make his headquarters in the company's home offices, 500 Fifth Avenue, New York 18, New York.

Percy Jenkins continues as sales manager of the Hardware Products Division.

Nomads "Wing Ding" A Great Success

More than two hundred Nomads and guests gathered at the Riviera Country Club near Los Angeles for the Fourth Annual "Wing Ding" of the Los Angeles Chapter of Nomads on July 23. The event opened at noon with a golf tournament and continued until nearly midnight with an elaborate floor show topping off the affair.

Sixty-six oil company and equipment men competed in the golf tournament. Prizes for net scores consisted of merchandise orders at Bullock's Wilshire and the first prize of $25.00 in merchandise was won by Dave Bradbury with a low net of 62. The second prize valued at $20.00 went to L. W. Ballard. The next three prizes valued at $10.00 each were won by three men who tied with net scores of 66. These were L. George Trembley, B. H. Dyson, and Tommy Severns.

Games of skill were then played with stage money, each Nomad and guest being given a quantity of this stage money when he entered. The object was to accumulate as much as possible and then use it for bidding for prizes during the dinner hour. This auction, together with the awarding of the golf prizes and drawing for a door prize, was conducted by a moving picture actress obtained for the occasion. First prize, auctioned off last, was a traveling bag and was won by Earl (Pop) Atkins. Second prize was a gaming set won by Henry Grinnell; third was a lap robe won by Mat Reardon; and fourth, an old-fashioned muddler, won by Ray Morris. The door prize went to L. George Trembley who seemed to be running in luck.

Dinner being completed by the end of the auction, the master of ceremonies was introduced and the floor show began. The hit of the show was a blindfold, mind-reading act.

Plans and arrangements for the "Wing Ding" were made and carried out by the Wing Ding Committee consisting of: Fred Tyler, sergeant-at-arms and chairman; Henry Pullman, president of Los Angeles Chapter, ex-officio; L. George Trembley, assistant chairman, in charge of golf, assisted by Tom Martin; Ernie Fowks, marshal; J. V. Robinson, in charge of games assisted by Tom Martin, Roger Henquet, Ray Humphries, John Shea, and Paul Hilton; E. R. Smith, prizes and finance, assisted by Jack Ballagh, and W. A. Sawdon, in charge of floor show.

"CLEVELANDS"

Dig Them All...

TRENCHES For:

Long Main Lines
Gathering Lines or Loops
Short Scattered Field Lines
"Hot-Spot" Reconditioning
Stripping Pipe for Reconditioning and Relaying
Ordinary Maintenance

Finely balanced, correctly designed, powerful, rugged, fast, easily maneuverable, and highly resistant to wear and abuse, "CLEVELANDS" represent the utmost in economy and efficiency—that's why they are today delivering highly efficient, low cost performance day in and day out on many U. S. Government projects and war emergency pipe line ditching jobs.

THE CLEVELAND TRENCHER COMPANY
20100 ST. CLAIR AVE. "Pioneer of the Small Trencher" CLEVELAND, OHIO
"CLEVELANDS" Save More... Because they Do More

Franklin Supply Moves To New Quarters

After a general sales meeting attended by the field men from the Mt. Pleasant, Michigan, and Mt. Vernon, Illinois, branch stores, the Franklin Supply Company on July 23 held open house in its new and larger general offices at 600 South Michigan Avenue, Chicago, Illinois.

Entering business in Mt. Pleasant, Michigan, in 1933 the Franklin Supply Company under the direction of President Jene Harper has made rapid progress and is today the oil-field distributor for a substantial group of oil-field equipment manufacturers.

Approximately 150 oilmen and equipment salesmen dropped in to see the new layout and to renew acquaintances.

The various desks, tables, and filing cabinets were covered with congratulatory floral offerings. In its ten years' service to the industry the Franklin Supply Company has not only acquired an important group of lines but in addition has acquired an imposing group of friends.

Foster Sales Head Pittsburgh Equitable

D. D. FOSTER

Announcement has been made by Major A. E. Higgins, vice-president of the Pittsburgh Equitable Meter Company, who is now in active service in the Army Air Corps, of the appointment of Donald D. Foster as assistant sales manager.

Foster formerly was district manager for the Pittsburgh territory. In his new capacity he will be acting head of the sales divisions for both the parent concern and subsidiary, the Merco Nordstrom Valve Company. He is a native of Pittsburgh and a graduate of Carnegie Institute of Technology.

D. W. Wilson Joins Arthur G. McKee & Co.

Arthur G. McKee and Company, Cleveland, Ohio, designing and construction engineers in the petroleum refining and iron and steel industries, announce the appointment of Dustin W. Wilson as technical director of their petroleum refining division.

During the last few years, Wilson has served as technical consultant of the Refining Division of the Petroleum Administration for War, in which capacity he had an important part in helping PAW develop a war program for the petroleum refining industry.

Wilson is widely recognized as a refining technologist and has been an active chemical engineer for 26 years. He was educated at the University of Maine and at the Massachusetts Institute of Technology where he received a B.S. degree in chemistry in 1917.

For ten years prior to joining PAW, Wilson was associated with M. W. Kellogg Company as a chemical engineer and a sales, engineering, and designing executive. He was also a director of the company.

Other positions held by Wilson include those as chemist for the U. S. Bureau of Mines and the Chemical Warfare Service in World War I, chemist for National Carbon Company, assistant professor of chemical engineering at M. I. T., chemical engineer for Iroquois Gas Corporation, and vice-president of Dry Quenching Equipment Corporation of New York.

Yes, sir! AMERICAN HEAVY DUTY ROLLER BEARINGS are made to take all you can give them—and more! Put them to the most abusive, gruelling service you can think of . . . in the heaviest, most powerful equipment built . . . and they'll carry the load smoothly and easily, with minimum maintenance for maximum periods, often outlasting the equipment itself. No wonder AMERICAN HEAVY DUTY ROLLER BEARINGS are specified by most major manufacturers and designers of oil country equipment.

Write today for complete engineering data

AMERICAN ROLLER BEARING COMPANY
PITTSBURGH, PENNSYLVANIA

Pacific Coast Office: 1718 South Flower St., Los Angeles, Calif.

AMERICAN
Heavy-Duty ROLLER BEARINGS

Ensign Heads Eastern Division Lee C. Moore

Lee C. Moore & Company, Inc. have announced the appointment of Lloyd G. Ensign as general manager of the company's Eastern Division, to take effect immediately. Ensign will make his headquarters at the administrative offices in Pittsburgh.

LLOYD G. ENSIGN

Prior to this appointment Ensign has been with the company for the last five years as export manager and New York representative at 30 Rockefeller Plaza, New York. The New York office will be maintained and the activities will continue under Ensign's direction in addition to his new duties.

Huizinga Joins National Supply Company

A. T. Huizinga has resigned as assistant treasurer of Montgomery Ward and Company to become treasurer of The National Supply Company at Pittsburgh, Pennsylvania. Subsequent to his association with a group of Chicago banks from 1920 to 1928, Huizinga was connected with the Harris Trust and Savings Bank of Chicago from 1928 to 1932. During this time he was active in the American Bankers' Association, the Financial Advertisers' Association, and a director in the American Institute of Banking.

Huizinga joined Montgomery Ward and Company in 1932 and was elected assistant treasurer in 1934, which position he has held until the present time. He has been active in civic affairs in Chicago, being a divisional chairman of the Community Fund for many years, a member of the Board of Managers of the YMCA of Chicago, and an officer of several other philanthropic organizations.

M. R. Rosse Made Export Sales Manager

The Wickwire Spencer Steel Company has announced the appointment of Matthew R. Rosse as sales manager, Export Division, succeeding W. H. Lynn.

Rosse is a native of Glasgow, Scotland, but was educated in the United States. He has had more than 25 years' continuous experience in the exportation of steel products and industrial equipment.

Rosse has traveled extensively abroad, especially in Europe and the Latin American countries.

Prior to joining Wickwire Spencer, he was for the last eight years assistant export manager of the American Chain and Cable Company.

Rosse will have his headquarters in the company's general offices at 500 Fifth Avenue, New York 18, New York.

Dow Division Wins Army-Navy "E"

Ceremonies incident to the presentation of an Army-Navy "E" award to employees and management of the Pittsburg, California, plant of the Great Western Division The Dow Chemical Company were held on July 28.

The signal award, "for high achievement in the production of war materials," is the sixth such honor to go to various operations in the domestic production set-up of the Dow company.

The Great Western Division, with its main plant at Pittsburg, California, has headquarters at San Francisco and operations along the Pacific Coast ranging from Los Angeles to Seattle. Normal peacetime products are industrial chemicals, organic solvents, compressed gases, and flotation reagents.

CRAFTSMANSHIP AT ITS BEST
HILL-HUBBELL PIPE PROTECTION IS MODERN CRAFTSMANSHIP
HILL-HUBBELL Steel Pipe Protection is applied at these leading mills.
Jones & Laughlin Steel Corporation
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Spang Chalfant, Inc.
Cellini, Robbia and Donatello were the recognized artist craftsmen of their day. Their fine jewelry and armor design are still tops in the skilled arts.
But the SKILLED CRAFTSMANSHIP in HILL-HUBBELL Pipe Protection does a more practical job. It conserves the long, useful life of Steel Pipe in the gas, oil and water industries where planned transportation is so important.
GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
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Army-Navy "E" to Gustin-Bacon

James A. Forrestal, Under Secretary of the Navy, recently sent a notification to the "men and women" of the Gustin-Bacon Manufacturing Company with general offices and plants in Kansas City that the Army-Navy "E" Award had been

Left to right—Rear Admiral Charlton, J. F. Stephens, J. O. Brelsford, and A. L. Gustin, Sr.

conferred upon them for "outstanding production of war materials." This company has division offices in New York, Philadelphia, Chicago, Tulsa, Houston, and San Francisco.

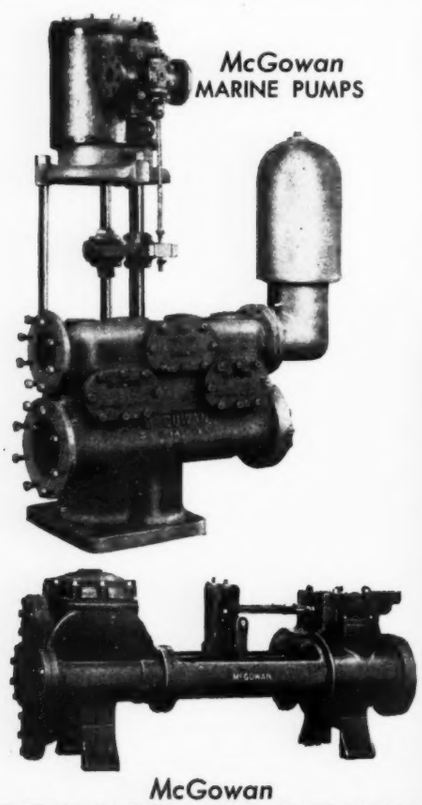
The award was presented by Rear Admiral Alex M. Charlton and Lt. Colonel Arthur R. MacLean.

In acknowledging the award, A. L. Gustin, president, replied with: "not only will it serve as a constant reminder of the part which our employees have played in winning the battle of production, but it will also serve as a challenge to maintain and improve that record in the future."

Among the guests were Captain "Dixie" Kieffer, Commanding Officer of the Naval Air Station at Olathe, Kansas; Captain W. R. Dowd, Supervisor of Shipbuilding, Chicago area, and Lt. Col. L. G. Schlegel, Army Air Corps.

Perkins Holds Note and Also Hand

E. V. Perkins, Chicago advertising representative of *The Petroleum Engineer*, showed the convention of the National Industrial Advertisers Association that he can warble a mean note—especially when in the hands of Singer Lucy Monroe.



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MARINE PUMPS

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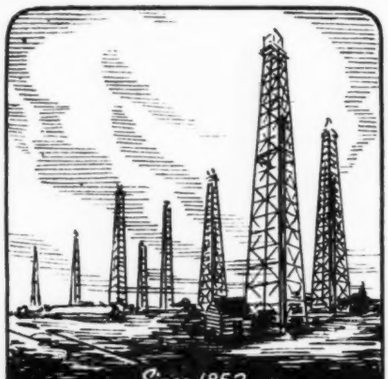
PISTON PACKED VALVE PLATE PUMPS



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DUPLEX and SIMPLEX

The McGowan Pump Division of the Leyman Manufacturing Corporation guarantees accurate workmanship and durable service. An experienced Engineering Department is available for information on installations and requirements. Highly efficient and ruggedly constructed — McGowan Pumps have the ability to stand up year in and year out under severe service conditions.

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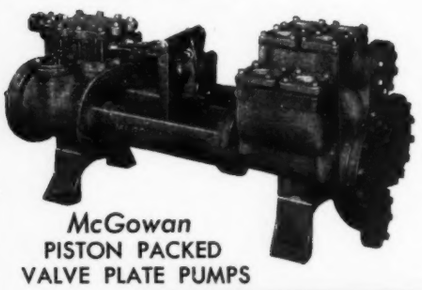

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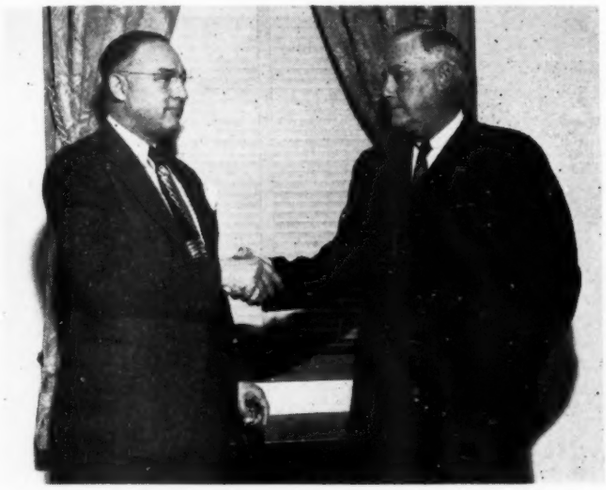
VALVE PLATE PUMPS

58 Central Avenue
Cincinnati, Ohio

McGowan Pumps · *Division of the* LEYMAN MANUFACTURING CORP.

"Dutch" Zwerneman Joins PAW

Announcement has been made by J. C. Axelson, president of the Axelson Manufacturing Company, that Alvin "Dutch" Zwerneman, vice-president and associated with the Axelson organization for the last 20 years, is severing his company association for a Washington, D. C. connection. He left California July 15 for Washington to become associated with the PAW under the leadership of Frank A. Watts, Director of Materiel.



J. C. Axelson (right) wishes "Dutch" Zwerneman success in his new work.

Zwerneman's title will be that of special assistant to the director of materiel and he will represent the petroleum equipment manufacturers and suppliers. It is understood that his work will have to do with the coördinating of raw material sources for manufacturers of petroleum industry equipment.

Zwerneman's appointment is the result of a special meeting of the Petroleum Equipment Suppliers' Association held in Dallas, Texas, April 23, 1943. At that time a resolution was adopted to recommend to PAW that a special section be created in the office of the Director of Materiel to deal with the needs and problems of petroleum equipment manufacturers and suppliers. The resolution further stipulated that such section be staffed in part by outstanding men from the industries affected.

Zwerneman's place is being taken by Ken S. Ramey, who will act as temporary California sales manager. Ramey is another Axelson veteran. He has been with the Axelson organization for more than 20 years.

Maloney Tank Enlarges Plant

Maloney Tank Manufacturing Company, Tulsa, Oklahoma, has doubled the size of its plant in order to manufacture both bolted and welded tanks, separators and pressure vessels, according to O. W. Maloney, president. The firm has for 30 years made bolted steel tanks, which it originated and patented. Increased production has caused rapid growth in the last year or so. A welding plant was recently added to the company and new tools, machinery, lathes, and equipment have been installed. A power roll that makes up to 1¾-in. plates has also been purchased.

Bibliography of Petroleum Literature

A bibliography on the literature of the petroleum industry is in preparation by the Petroleum Engineering Department of A. and M. College of Texas. It will comprise some 20,000 items. These will be arranged chronologically by subject and classified according to the Dewey Decimal System.

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complete line of industrial equipment

STYRENE PRODUCTION adds to the uses of

New synthetic rubber plant set in operation by The Firestone Tire and Rubber Company on Sunday, April 25. Butadiene, a by-product of gasoline refining, and styrene, a coal-tar product, are emulsified and combined to make Buna rubber. Capacity equivalent to that of 100,000 acres producing natural rubber.

THE most advanced technical processes in which desiccants and adsorbents are required, give new emphasis to the useful properties of FLORITE. Production of synthetic rubber by the styrene-butadiene process is an interesting and timely example. FLORITE has found immediate adoption and proved highly satisfactory in the great chemical plants where by "modern magic" styrene is produced.

In the drying of propane, butane, air, nitrogen, carbon dioxide, refrigeration compounds, and other fluids, FLORITE is used with marked success. Long-term effectiveness results in economy of cost. Write for data.

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TRADE LITERATURE

What to Write For

BULLETINS ON air cleaners and filters have been prepared by American Air Filter Company, Inc., 384 Central Avenue, Louisville, Kentucky, and will be sent upon request. Bulletin 130D describes the Cycoil gas cleaner and its operation. Bulletin 120D contains information about the PL-H filter and Type Och filter.

ARMSTRONG BROTHERS TOOL COMPANY has completed a booklet on its ratchet pipe reamer and pipe vise saddle, which is available upon request. Catalog C-639a will be sent from the main office, 331 North Francisco Avenue, Chicago, or from the eastern headquarters, 199 LaFayette Street, New York.

FRANCE RINGS FOR METAL PACKING are described fully in Catalog M-3 to aid in analyzing packing requirements. The rings are for installation in engines, pumps, and compressors. Write The France Packing Company, Tacony, Philadelphia 35, Pennsylvania, for a copy.

A CHART ON "HOW TO KNOW VALVES" has been released by the Reading-Pratt and Cady Division of American Chain and Cable Company, Inc., to aid new, and perhaps some more experienced, maintenance workers in industry. The chart breaks down valves into four basic types; shows simple line illustrations; explains the service they perform and how they operate, and where valves are used. Copies of the cardboard chart will be sent upon request to the company at Bridgeport, Connecticut, attention, Department S.P.

AN EXHAUSTIVE STUDY of industrial valves is contained in a 324-page catalog recently published after five years in the making by Darling Valve and Manufacturing Company, Williamsport, Pennsylvania. The work contains more than 600 photographs, sectional views, designs, detailed drawings, and other illustrations, with technical contributions by engineers. For use in plant design, construction, and maintenance, the book will be sent upon request.

SAFETY ENGINEERS will be interested in the new McDonald Manual, a discussion of safety equipment and its specific uses. Published by B. F. McDonald Company, 1250-M South Hope Street, Los Angeles 15, California, the volume is available without charge. It is divided into eight sections: Head Protection, Eye Protection, Respiratory Protection, First Aid, Safety Clothing, Gas Masks, Safety Instruments, and Miscellaneous Safety Appliances.

AN ATTRACTIVE BOOKLET, beautifully illustrated, has been released by the Buckeye Traction Ditcher Company, Findlay, Ohio, and will be sent to those requesting a copy. The 24-page bulletin shows in photographs the wide uses and features of "Mevac" vacuum power control. Buckeye Clipper shovels, cranes, trench hoes, draglines, and pile drivers on war and prewar jobs are pictured.

INFORMATION ON the nine types of Hy-Load Bearings is contained in Bulletin 541A, published by Hyatt Roller Bearings, General Motors Corporation, Harrison, New Jersey. A copy will be sent to any one who has a radial bearing problem and is interested in a special type of bearing to do a specific job.

American Well and Prospecting Company Awarded "E"

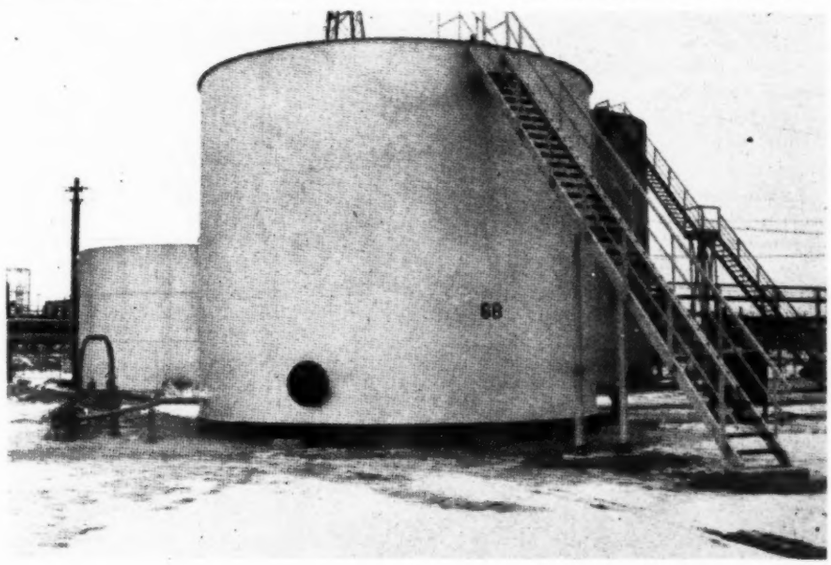
For outstanding production the Army-Navy "E" pennant was presented to the American Well and Prospecting Company, which manufactures armour-piercing bombs. At the presentation at Corsicana, Texas, were: Colonel Merle H. Davis, chief, St. Louis Ordnance District; Colonel R. W. Coward; R. D. Campbell; J. E. Rittersbacher, president of the company; Lieutenant Commander Roy J. Miller; F. A. Westphal and Rear Admiral P. W. Foote, inspectors of naval material. In the insert is Edgar Rittersbacher, vice-president and treasurer of the American Well and Prospecting Company.

A. S. Glossbrenner Promoted by Youngstown

J. L. Mauthe, vice-president in charge of operations of The Youngstown Sheet and Tube Company, announces the appointment of Albert S. Glossbrenner as general superintendent of the Youngstown district. He succeeds Mauthe, who was appointed vice-president as of July 1.

A. S. GLOSSBRENNER

Glossbrenner was superintendent of the sheet and tube company's Brier Hill plant. After attending the University of Wisconsin he became interested in the steel industry. About 13 years ago he entered the employ of the old Illinois Steel Company, one of the predecessors of Carnegie-Illinois Steel Corporation, at the Gary, Indiana, tinplate plant. He then transferred to the same company's South Works at Chicago as assistant foreman. He went to Youngstown eight years ago as assistant superintendent of the hot strip mill, becoming superintendent about three years later. He was appointed as superintendent of the Brier Hill plant in September, 1942.



BASOLIT

Protection Against Acid

This 30 ft. diameter x 25 ft. high steel tank, one of a number recently installed in one of the largest refineries in the country, for storage of 50 per cent hot sulphuric acid, is protected with a double lining of BASOLIT and Acid-Proof Brick.

BASOLIT sulphur base jointing compound has been used successfully for over fifteen years in construction of acid tanks, floors and sewers in oil refineries, chemical plants, steel mills and other industries where acid problems exist.

Our Engineering Department will be pleased to furnish drawings and estimates without cost or any obligation on your part.

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HIGHER CUTTING EFFICIENCY from SEISMOGRAPH BITS

Hard-Facing Recommendations For Obtaining More Footage—Faster Cutting—Less Down-Time For Bit Resharpening

1 Always include at least one Borium insert at the lower, outside corner of each cutting wing to prevent "diamond pointing." (Sketch)

2. On bits larger than 6 inches O.D a second Borium insert on the lower cutting edge improves drilling efficiency. (Sketch)

3. Cover leading faces of all bit wings with Tube Borium, using screen size of at least 10-20 mesh rather than finer meshes such as 30-40. Tests conclusively prove the larger Borium particles greatly increase drilling speeds.

4. Don't skimp on quantity. Tests show that bit life and efficiency is in direct proportion to the amount of Tube Borium applied (up to ⅛" in thickness).

More Seismograph Bits Are Hard-Faced With Tube Borium Than Any Other Alloy

STOODY COMPANY

1142 West Slauson Ave., Whittier, Calif.

STOODY HARD-FACING ALLOYS
Stop wear . . . Eliminate Repair

Welding Library Established at Ohio State

A new library on welding, believed the most extensive in existence and one which will be of inestimable value in welding development, has been established at the Ohio State University, according to E. N. Manchester, university librarian.

Known as the "A. F. Davis Welding Library," it is the gift of A. F. Davis, vice-president and secretary, The Lincoln Electric Company, Cleveland, Ohio. Davis received the degree of M.E. in electrical engineering from the university in 1914 and his reason for placing the library there was the fact that Ohio State has the only four-year course in welding engineering.

"The donor's expressed wish that the library contain every book, manuscript, article or document which could be considered of value from the standpoint of adding useful reference information on welding, is being followed in expanding this new facility," said Manchester. "We are constantly exploring possibilities of books to be added in both this country and abroad and are inviting engineers doing original research in welding to send their original papers to the library for filing and for use by the industry in the future."

Though in its early stage of development, the library already contains more than 700 books. Included are those on metallurgy, designing for welded construction, welding techniques and procedures, properties of weld metals, standard welding handbooks, bound volumes of welding magazines, the award studies of The James F. Lincoln Arc Welding Foundation, patents relating to welding, and countless other subjects.

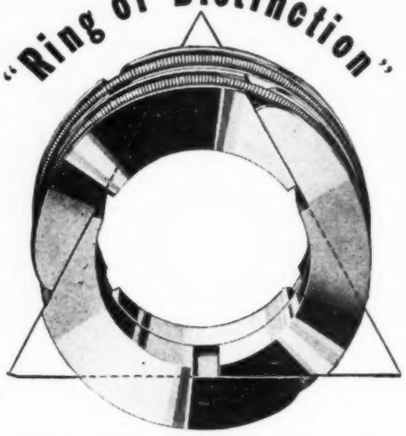
Davis, who made the library possible, has spent 29 years in the welding industry. During this time he has seen welding processes develop from little more than laboratory experiments into a large industry.

J. S. Carroll Retires

The retirement of J. S. Carroll, vice-president, has been announced by Lewis H. Brown, president of Johns-Manville. Carroll has been associated with Johns-Manville for 32 years, first as sales representative in the Philadelphia district, later as architect's representative in the New York headquarters. In 1915 he was appointed sales manager of Metropolitan New York. Because of his success in serving the oil companies in the Metropolitan area, he was given the responsibility by T. F. Manville of forming a department to service the oil industry throughout the United States. In 1923 he was elected vice-president of the company.

FOR THE DEFENSE OF DEMOCRACY
THE BEST IS NONE TOO GOOD

FRANCE PACKING has a "Ring of Distinction"



Imitated but never duplicated, the France ring is manufactured in three sections. The contacting faces form the lines of an equilateral triangle. As the ring is expanded or contracted, the sections must move in or out radially equal distances from the center of the rod to which the ring is fitted. This fundamental mechanical principle accounts for the efficiency, trouble-free performance and extra-long life of France Metal Packing.

After years of service, when the rings have become worn to such an extent that the sections nearly butt together, further years of additional service can be obtained by cutting off the narrow points of the three sections where they form a part of the inner circumference of the ring. The spring then requires adjustment so that the sections are held to the rod with a slight tension.

For installation in engines, pumps and compressors—under all conditions of service, France Full-floating Metal Packing means true economy in the long run.

Permit France Engineers to analyze your packing requirements.

Write for Catalog M-3

Sold on approval
Satisfaction Guaranteed

THE FRANCE PACKING COMPANY

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FORT WORTH, TEXAS

Original FRANCE METAL PACKING

INCREASE CAPACITY

of Boilers and Tubes—Keep All Heat Transfer Surfaces Clean

SAND-BANUM

Automatically Removes and Prevents Scale and Corrosion

"The Entirely Different Boiler and Engine Treatment"

Sand-Banum affords you a very definite and economical means of increasing the productive output of your fuel. It reduces fuel consumption, increases combustion efficiency and extends equipment life.

The automatic operation of guaranteed Sand-Banum lessens time out for shut-downs and promotes maintained capacity operations. Write today for details.

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza New York City

Salt Water Company to Expand Facilities

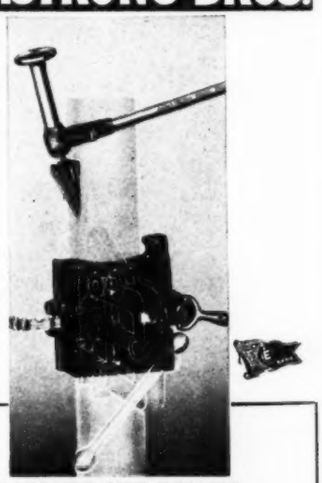
At a meeting of the board of directors of the East Texas Salt Water Disposal Company recently, it was decided to call in the outstanding stock subscriptions amounting to approximately $500,000 to provide funds for increasing salt water disposal facilities in the East Texas field. The installation of new facilities to return additional salt water to the Woodbine sand was approved by the Petroleum Administration for War in Washington insofar as obtaining necessary materials for the work was concerned. The Railroad Commission of Texas likewise expressed its approval of the program to date and endorsed the expansion program. The subject was briefly discussed at the statewide hearing of the Railroad Commission in Austin on July 16, 1943, at which time the reservoir pressure in the East Texas field for the last six months was reviewed.

On January 1, 1943, the average reservoir pressure in the East Texas field was 1015.71 lb. per sq. in. and on July 1, 1943, the average pressure was 1016.98 lb. per sq. in. During the six-month interval the pressure showed an increase of 1.27 lb. per sq. in.; during this period of time, the field produced 60,550,512 bbl. of oil (daily average 334,533 bbl.) and 56,924,494 bbl. of water (daily average 314,500 bbl). During the same period 26,955,613 bbl. of water were returned to the Woodbine sand (daily average 148,926 bbl.).

The additional funds called in by the Salt Water Company will be used for drilling six new injection wells and installing gathering lines and treating facilities in parts of the field not heretofore served by disposal facilities. Two of the new projects have already been started.

Look for the Arm-and-Hammer

ARMSTRONG BROS.



RATCHET PIPE REAMER and PIPE VISE SADDLE

Use an ARMSTRONG BROS. Ratchet Pipe Reamer to assure full capacity, trouble-free pipe work. Its spiral fluted reamer quickly eliminates all inside burrs for it is milled, ground and hardened. Its drop-forged reversible ratchet operates in the closest quarters—only a 12½-degree handle swing required. Will give lifetime service.

The ARMSTRONG BROS. Pipe Vise Saddle brings the vise to the point of work. Attaches instantly to any pillar or post and provides a secure base (and pipe or conduit bender) for either hinged, chain or open side pipe vises.

Write now for full description catalog C-639a

ARMSTRONG BROS. TOOL CO.

"The Tool Holder People"

311 N. FRANCISCO AVE. CHICAGO, U.S.A.

Eastern Warehouse & Sales: 199 Lafayette St., New York

Pump Test Code Revised

Hydraulic Institute, 90 West Street, New York 6, New York, the national trade association of pump manufacturers, announces complete revision of the Test Code Section of its Standards.

This Test Code Section, first published in 1936, contains specific recommendations for the testing of centrifugal and rotary pumps, both for acceptance tests in the field, and in the plant of the pump manufacturer.

The Code contains the limiting conditions for all methods of quantitative determination of capacity, head, and power input, whereby the accuracy for an acceptance test can be obtained.

Spang Chalfant Appoints New Sales Manager

Spang Chalfant, Inc., division of National Supply Company announces the appointment of R. M. Burk as manager of sales for seamless products.

R. M. BURK

Upon his graduation from Cornell University in 1922, Burk entered the oil business in the employ of Waite Phillips Company, Tulsa, Oklahoma. In 1926 he joined The National Supply Company as division tubular manager, Los Angeles, California, and later in succession became manager of sales, Spang Chalfant, Los Angeles, and manager of sales, Spang Chalfant, St. Louis. In 1940 he returned to Los Angeles as assistant to the vice-president of The National Supply Company, which position he leaves for his new assignment.

Burk will assume his new duties September 1, 1943, with headquarters in the general office of Spang Chalfant, Grant Building, Pittsburgh, Pennsylvania.

For QUICK, ACCURATE TESTS Use CURTIN CENTRIFUGES

No. 3420 15 c.c. machine .... Cranks and heads interchangeable with 100 c.c. machines.

Simple in design ... Ruggedly built ... Require no special care ... Great Ratio and throw of crank produce required speed with no strain. Curtin Centrifuges meet all *A.S.T.M. Standard Method D-96-40* and *A.P.I. Code No. 25* requirements. Fully descriptive literature upon request.

W·H·CURTIN & CO. Inc

HOUSTON U.S.A. TEXAS

SPERRY-SUN

Better To be Safe Than Wrong

Anything less than the best in well surveys is poor economy. The assurance of speed, accuracy and more profitable operation warrants the use of Sperry-Sun Surveying Devices and Technical Services.

SURWEL Clinograph	H-K Single Shot
SYFO Clinograph	M-M-O Bottom Hole Orientation
E-C Inclinometer	K-K Whipstock
H-K Inclinometer	Polar Core Orientation

SPERRY-SUN WELL SURVEYING CO.
PHILADELPHIA, PA.
HOUSTON, TEXAS LONG BEACH, CALIF.

VALVE SEAT INSERTS
Can be taken for granted on **ALL**

WISCONSIN HEAVY-DUTY
***Air-Cooled* ENGINES**

To provide the most satisfactory heavy-duty service and to reduce replacement costs to a minimum, ALL Wisconsin Engines are made with renewable valve seat inserts, made of costly chrome-nickel molybdenum alloy. You have less valve grinding to do, fewer tappet adjustments to make... and a simple replacement job.

Just one of many "better-than-average" details of Wisconsin Engine construction that help to maintain trouble-free service schedules for Wisconsin-powered equipment.

MOST POWER PER POUND

WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 ATLAS BLDG., TULSA, OKLA.
M & M BLDG., HOUSTON, TEXAS
OIL FIELD DISTRIBUTOR FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

Book Reviews

Fightin' Oil by Harold L. Ickes. Published by Alfred A. Knopf, 501 Madison Avenue, New York. Pages, 174. Price, $1.75.

Asserting that he is not even a minor prophet, Harold L. Ickes proceeds to disprove in general and in detail his own statement in Fightin' Oil, the story of the oil situation in the present war by the Petroleum Administrator. No one is in a better position to reveal the history of preparation and operation of the American petroleum industry for World War II than the man who was named Petroleum Coördinator in May, 1941, by President Roosevelt. Ickes has data at hand that are essential in presenting an accurate panorama of the production, refining, and transportation of American oil as it moved into the vital position it occupies in the global war.

Despite the recurrent theme of "I told them so," the Petroleum Administrator has a gripping subject and he gives the reader frequent glimpses of the overwhelming drama of Fightin' Oil. From the time when 100-octane confounds the villain and saves the old homestead for Britannia to the prophecy he permits himself of the future of oil in the air, Ickes tells a lively tale.

Petroleum Development and Technology, 1943. Published by Petroleum Division, American Institute of Mining and Metallurgical Engineers, 29 West 39th Street, New York 18, New York. Pages, 601.

Added duties and greater responsibilities have fallen upon members of the Petroleum Division of the A.I.M.E. in the effort to bring victory and peace but the *Transactions* have not suffered. This 151st volume of the Institute contains the papers and discussions presented at meetings in New York, Los Angeles, and Austin in 1942 and also gives petroleum statistical reports covering the same year.

The essential need for disseminating newly gained knowledge and information when scientific and technical research keeps only slightly ahead of practice has been recognized by the Petroleum Division and the annual volume of papers is the competent answer of a group that today is doing a bigger job than ever before.

Always an eminent text and reference book, *Petroleum Development and Technology* for 1943 has an especially important function in keeping the engineers in the industry informed of radical changes and innovations.

Oil Well Supply Drops Mexico Subsidiary

Oil Well Supply Company announces that its subsidiary in Mexico, Cia. Consolidada Oilwell S. A., has sold its properties and discontinued operations. Gilbert M. Davies, manager of the latter company for several years, will represent Oil Well Supply Company in Mexico.

M. A. King Now With Worthington

Worthington Pump and Machinery Corporation announces that Marcello A. King has joined the organization as executive engineer of its Moore Steam Turbine Division, Wellsville, New York, in charge of design, research, testing, and service. Engaged in turbine engineering and manufacture since his graduation from the University of Michigan in 1916, he was with the Kerr Turbine Company and later with the Elliott Company where he held the position of manager of engineering. King has been active in trade association work and is widely known in the steam power field.

Honors Presented Air Reduction Company

The Maritime "M" and Victory Flag for high production achievement was recently presented to the Air Reduction Company in Bethlehem, Pennsylvania, to its seven subsidiary companies, to all employees, and to the 159 plants, factories

Holding the "M" pennant awarded the Air Reduction Company are: Admiral Land; Walter J. Strawn, employee; C. S. Munson, president, and C. E. Adams, chairman, of the company.

and laboratories of the organization located throughout the United States. Admiral Emory S. Land presented the award in a colorful ceremony. It was accepted by C. E. Adams, chairman of the board, and C. S. Munson, president, on behalf of the company, and by Walter J. Strawn, oxygen plant worker, on behalf of the employees.

J. H. Kunkel Elected Vice-President N. I. A. A.

Elected to vice-presidency of National Industrial Advertisers Association, Inc., is John H. Kunkel, director of public relations and advertising at The Fluor Corporation, Ltd., Los

JOHN H. KUNKEL

Angeles, California. Kunkel is also a member of the board of directors of N. I. A. A. and president of the Los Angeles Chapter, Industrial Advertising Association of Southern California. It is his second term as head of the Los Angeles group.

Smile when you call an old workman decrepit—and think twice before you call an old Ludlow Valve an antique. Recalled to wartime service, both are proving their real worth. It's a good idea to look over your "retired" valves. If they're Ludlows, they can stage a surprising come-back when cleaned up and reoutfitted.

Ludlow Valves have always been designed for maximum endurance and replacement parts are usually available for old models. And, reasonably, it is easier to get priority for replacement parts than for a complete valve. Ludlow will gladly cooperate.

THE LUDLOW VALVE MFG. CO., INC.
TROY, NEW YORK

V-16

Construction Features: Self-releasing 30° angle wedges and free-floating gates, self-adjusting to seats, afford smooth, trouble-free performance, long service. Rings are cleaned throughout stroke action. Gates are wedge-locked directly opposite ports and completely unwedged before raising. Ample tolerances provide easy action. Simple construction permits easy replacement of parts.

LUDLOW VALVES SINCE 1866

Experience at Work!

In the DC JENSEN Pumping Unit you see at work the field experience of hundreds of producers, pooled, sifted and applied by JENSEN engineers and plant experts over a period of 25 years. No other way to pump a well offers so many advantages—advantages you can't afford to be without. Write for Bulletin No. 27.

JENSEN
BROTHERS MFG. CO.
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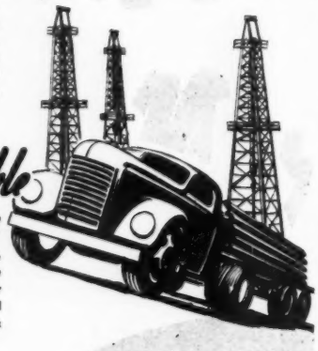
Export Office: 50 CHURCH STREET, NEW YORK CITY

ENSIGN
CARBURETORS

Working for Victory

ENSIGN Carburetors for Natural Gas, Butane-Propane and Gasoline are playing an important part in the Victory effort. We are proud of this fact and are devoting our modern facilities and long experience to the successful completion of this assignment. Helping to win the war is our chief duty at this time.



But still available
ON THE HOME FRONT

However, ENSIGN Carburetors for Natural Gas, Butane-Propane and Gasoline are still available for uses not directly connected with the war effort. It may take us a little longer than usual to supply the demand for carburetors, but quick delivery of emergency parts is assured.

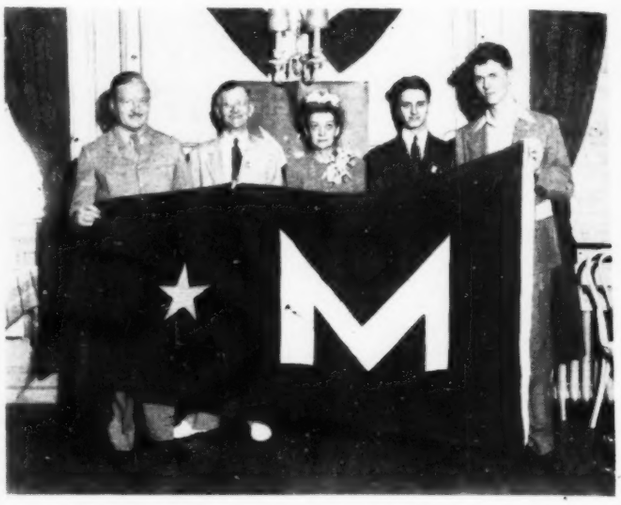
Now, as always, ENSIGN is unequaled for efficient and economical carburetion.

ENSIGN
CARBURETOR CO., LTD.
HUNTINGTON PARK • CALIFORNIA

Prepare, NOW, for post-war demands. Our competent engineering staff is at your service.

Reading Plant of American Chain & Cable Awarded Maritime "M"

On July 16, during the ceremonies held at their plant in Reading, Pennsylvania, the employees and management of the Reading-Pratt and Cady and Reading Steel Castings Divisions of American Chain and Cable Company, Inc., heard their production record praised by Colonel Willard F. Rockwell when he presented the "M" Pennant, Victory Fleet Flag, and Labor Merit Badges on behalf of the United States Maritime Commission.



In accepting the award, Lee C. Wilson, general manager of the two divisions of the company pledged continued support for the work ahead and said the pennant, flag, and badges will remind the workers of the importance of their individual jobs to the war effort.

Four representatives of the workers, Mrs. Margaret Brough, Mark L. Brown, Henry G. Zember, and Martin A. Powers, received Maritime Labor Merit Badges on behalf of their fellow-employees.

On behalf of the directors and stockholders, William T. Morris, president of American Chain and Cable Company, Inc., thanked the Maritime Commission for the honor bestowed on the Reading plant. He said the company appreciates especially the efforts of the families of the workers who have helped spur them on to greater production. He paid special tribute to the men from the company who are serving in the armed forces and the merchant marine and said they would be heartened by the news of the "M" Award.

Western Pennsylvania Engineers Meet

With the annual golf tournament a war casualty, due to the ban on pleasure driving in the East, the Oil and Gas Section of the Engineers' Society of Western Pennsylvania, on July 16, transferred summer activities to the William Penn Hotel in Pittsburgh.

A total of 176 members turned out for a technical meeting in the afternoon, followed by a reception and dinner in the evening. The afternoon program was in charge of D. D. Foster, assistant sales manager of the Pittsburgh Equitable Meter Company. B. C. Thiel, consulting engineer for The Cooper-Bessemer Corporation, read a paper "Modern Compressor Stations," and James F. Swain, geologist with the firm of Huntley and Huntley, covered the subject of "Interpretation of Driller's Log." Through the courtesy of The Barrett Division, Allied Chemical and Dye Corporation, the group was then shown the motion picture "Oil for War"—the story of the "Big Inch" line.

A "Dutch Treat" reception and dinner followed, under the sponsorship of a committee headed by H. H. Pigott of the Equitable Gas Company.

MEETINGS

California Natural Gasoline Association, Monthly Meeting—September 2, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Chemical Society, Petroleum Division, Fall Meeting, September 6, 7, 8, 9, and 10. Place of meeting not determined.

National Petroleum Association, Annual Meeting—September 21 and 22, Waldorf Astoria Hotel, New York City.

Interstate Oil Compact Commission—September 24 and 25, Santa Fe, New Mexico.

American Association of Oilwell Drilling Contractors, Annual Meeting—October 5 and 6, Houston, Texas.

American Gas Association, Annual Meeting—October 11, 12, and 13, Jefferson Hotel, St. Louis, Missouri.

Mid-Continent Oil and Gas Association, Annual Meeting—October 14 and 15, Blackstone Hotel, Fort Worth, Texas.

Independent Petroleum Association of America, Annual Meeting—October 25, 26, and 27, Fort Worth, Texas.

American Petroleum Institute, Annual Meeting—November 8, 9, 10, and 11, Palmer House, Chicago, Illinois.

Exposition of Chemical Industries—December 6, 7, 8, 9, 10, and 11, Madison Square Garden, New York City.

Petroleum Industry Electrical Association and the Petroleum Electric Supply Association—Last week in April, 1944, Dallas, Texas.

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FUTURE PREFABRICATION IN OUR SOUTHLAND

We have built more than 10,000 homes in 25 years; we were in the vanguard in giving validity to the prefabrication principle; our credo—*time* is what we make—*speed* is what we deliver—*quality* is what we provide.

Our plant is now in full production, serving industry in its war requirements; after VICTORY we'll be on the alert to serve again civilian needs.

Buy a home in the peace to follow
—with the Bonds you buy today.

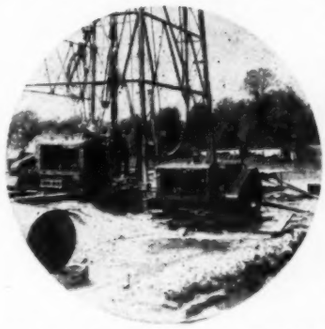
WORKING NOW FOR **U. S.** BUT LATER FOR YOU

HOUSTON *Ready-Cut* HOUSE CO.
25 years Prefabricating Houses
POLK AVENUE HOUSTON, TEXAS

How Marine Derrick Power Transmission Will Speed Pumping

Several time, labor and expense saving clutch improvements, developed by war emergencies, will be adapted for post-war products. For the duration, some of these improvements are not available in civilian products. But ideas are not rationed. Your future may depend upon re-designing your product for post-war markets. Let our engineers suggest new peace-time clutch applications using

ROCKFORD *Industrial* CLUTCHES *and* POWER TAKE-OFFS



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They tell and show how our engineers have made ROCKFORD CLUTCH and POWER TAKE-OFF applications that are saving power, time and money in a wide variety of industries. Give capacities, dimensions and specifications. Contain application diagrams. Product engineers need these bulletins.

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Remember when you could call up in the morning and have a new replacement part delivered in the afternoon?

Now it's quicker—cheaper—to hard-surface all wearing parts with COLMONOY. Equipment that must take a lot of punishment—perhaps for 24 hours a day—will operate efficiently, with less wear, when the proper grade of COLMONOY is used as a hard-facing for all parts subject to excessive abrasion and corrosion. It will pay *you* to investigate!

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Hard Surfacing Alloys and Overlay Metals

Tube Borium Keeps 'em digging

STOODY TUBE BORIUM* KEEPS DITCHER TEETH SHARP ...ELIMINATES FREQUENT SHUT-DOWNS FOR TOOTH CHANGES...CUTS REPLACEMENT COSTS UP TO 75%

The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.
The unprotected tooth at the top had to be sharpened every three days and was too short for further service after six sharpenings.
But the Borium-protected tooth at the bottom operated for 40 days and wore only ½". It was simply resharpened in the forge, retipped with Tube Borium, and put back on the ditcher for another 40 days' service.
Before the tooth was finally worn out, it had operated a total of 120 days!
Tube Borium makes such savings possible because the deposits represent the ultimate in wear resistance and the ability to cut hard earth formations.

*Stoody Tube Borium is supplied in rods of ⅛", 5/32", ¼" and ⅜" diameters and is available for either oxyacetylene or D.C. electric application. Prices and specifications are yours for the asking.

These tungsten carbide particles do not melt when tube is applied but are held in suspension in a mild steel matrix forming a deposit resembling coarse sandpaper.

Send for free booklet on TUBE BORIUM, showing sizes and styles of rods and recommended methods of application.

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Stop wear... Eliminate Repair

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